REVIEW ARTICLE

The Emerging Role of Endovascular Portal Interventions in Pakistan

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Abstract

To outline new modalities and techniques offered by Interventional Radiology (IR) in diagnosing and treating patients with complications related to portal hypertension and techniques to induce remnant liver hypertrophy to enable hemi hepatectomy in Pakistan.

Known portal hypertensive patients were selected retrospectively including those for portal vein embolisation. Selected cases are presented to outline the treatment modality technique and its effectiveness using minimally invasive IR-based treatment options.

Different techniques used by interventional radiologists are now also available in Pakistan and are paramount in managing the complications of portal hypertension and inducing remnant liver hypertrophy.

Minimally invasive procedures offered by IR continue to evolve with technological innovations and are now available to manage complications related to portal hypertension hitherto not thought of and which profoundly improve patient care.

Keywords: *Portal hypertension, TIPS, Hepatic venous recanalization, interventional radiology.*

INTRODUCTION

Portal hypertension reflects an increase in portal pressure with cirrhosis being the most notorious cause. Radiology not only aids in diagnosing these but also assists in treating them through minimally invasive IR (interventional radiology) guided procedures. Various treatment options for portal hypertension are available depending on the etiology of the disease [1]. The most frequently used in our setup is TIPS (transjugular intrahepatic portosystemic shunt), used to reduce portal pressure by forming a channel between the portal vein and the hepatic vein. Thus, TIPS reduce many portal hypertension-associated complications like medically resistant ascites, variceal bleeding etcetera [2]. Transjugular hepatic biopsy provides a safe alternative for patients where percutaneous hepatic biopsy is contraindicated, like in patients with ascites and coagulopathy [3]. Other procedures such as sharp hepatic venous recanalization for occlusive disease seen in the setting of Budd Chiari syndrome, CARTO (coil assisted retrograde transvenous obliteration), where gastric varices predominate and who have either failed traditional endoscopic therapeutic options or are not suited for treatment *via* an endoscopic approach and in whom TIPS is no longer considered to be the preferred option, portal vein embolization for remanent liver hypertrophy [4] to assist in surgical hemi hepatectomy to enable a curative surgical option for patients with HCC. This article briefly describes the procedures, their pictorial review, and their current status in the treatment of portal hypertension in a developing country like Pakistan.

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Received: April 25, 2024; Revised: July 21, 2024; Accepted: July 25, 2024
DOI: https://doi.org/10.37184/jlnh.2959-1805.2.26

MATERIAL AND METHODS

This study was performed retrospectively after the Institutional Review Board's approval. In this study, patients diagnosed with portal hypertension were included and those who would be potential candidates for hemi hepatectomy in the setting of HCC. We compiled different IR-guided techniques used over the time span of January 2022 to Dec 2023.

DISCUSSION

Different IR-guided techniques used in a single institute are hereby listed.

Transjugular Intrahepatic Portosystemic Shunts (TIPS)

TIPS, is a widely used, well-established, IR-guided technique, for portal hypertension patients (cirrhotic and noncirrhotic) with intractable ascites or variceal hemorrhage [5]. The shunt is formed by placing a stent between the portal vein and the hepatic vein (**Fig. 1**). The resultant shunting of portal venous flow to the systemic circulation helps in lessening the portosystemic shunt without causing any change in the extrahepatic anatomy [6]. Whereas previously bare metal stents were used with shorter patency rates nowadays the use of combined bare metal stents and stent grafts is used which provides a longer duration of TIPS patency [7].

A 65-year-old female with HCV cirrhosis and refractory ascites and varices (MELD score 13) presented to IR for TIPS placement. Access was made through an antegrade approach from the right internal jugular vein. Catheters used in this procedure were 5 Fr - 11 cm access sheath, 5 Fr C2 Catheter (Performa) and Rosche Uchida TIPS Puncture Set (Cook). The balloons used were 8 x 40 mm and 10 x 40 mm diameter. The stents used were a

  ISSN: 2960-2963 (Online).*Journal of Liaquat National Hospital 2025; 3(1): 36-42*

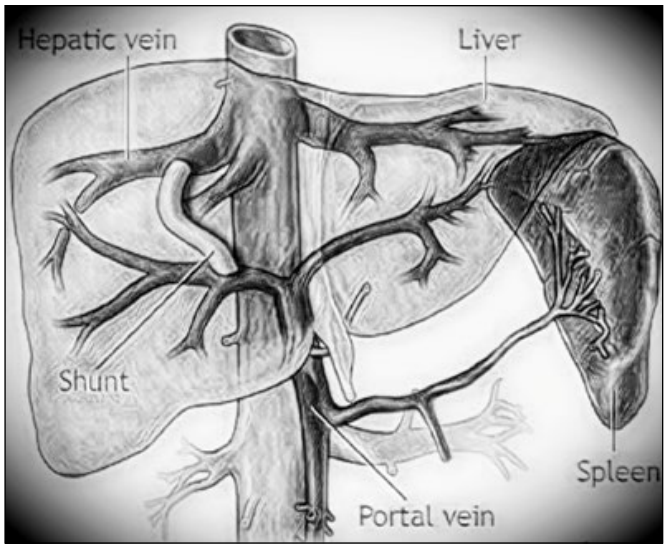

Fig. (1): TIPS illustration.

10 mm x 80 mm bare metal stent (Zilver) and a 10 x 60 mm covered Stent Graft (Fluency - BARD). Informed consent was obtained. The procedure was performed under general anaesthesia. Right IJV was punctured and a 5 Fr sheath was placed. A 5 Fr C2 catheter was advanced over the glide wire and both hepatic and portal venous pressures were measured (the technique for this is illustrated in the last case). The 5 Fr sheath was replaced with the TIPS set consisting of an outer 10-Fr sheath with the tip of its inner trocar directed towards the right hepatic vein which was cannulated and advanced. The TIPS sheathed needle was then used to puncture the anterior branch of the right portal vein making use of both fluoroscopic and ultrasound guidance. A hydrophilic guidewire was advanced into the main portal vein and a catheter advanced over it. The guidewire was replaced with a super stiff Amplatz wire and then a portal venogram was performed with a 5 Fr pigtail catheter. The parenchymal track was dilated with an 8 x 40 mm balloon and then a 10 x 80 mm self-expandable metallic stent deployed with its distal end in the right main portal vein, followed by overlapping placement of a 10 x 60 mm covered stent graft with the distal end in the parenchymal track and with its proximal end in the suprahepatic IVC. Bile is considered thrombogenic, which may lead to thrombosis and many studies in the literature suggest improved patency with covered stents [8, 9]. The stents were dilated with 8 x 40 mm and following portal venous pressure measurements repeat dilatation was performed using a 10 × 40 mm balloon. The final portal venogram showed a good flow of contrast in the TIPS with the disappearance of the collateral shunts seen earlier (**Fig. 2**). Pressures were again measured including those of the right atrium as patients undergoing TIPS are going through different hemodynamic conditions, that depends not only degree of cirrhosis but also on pre-existing factors like collaterals, fluid overload, cardiac conditions, diuretics [10]. Many studies in the literature have suggested pressure changes that occur post TIPS, from an increase in cardiac output to a decrease in systemic vascular resistance without significant changes in mean arterial pressure, early deterioration in liver synthetic function and a worsening in the hyperdynamic circulatory state of cirrhosis with an increase in sodium levels that correlates closely with decrease renin activity. However, no significant differences in glomerular filtration rate, creatinine clearance, serum creatinine, or serum sodium have been observed [11].

Fig. (2): Post TIPS.

Coil Assisted Retrograde Transvenous Obliteration (CARTO)

CARTO is a method for the treatment of bleeding portal hypertensive varices including gastroesophageal, stomal, duodenal, jejunal and rectal varices which involves the use of coils and gel form instead of vascular plugs, indwelling balloons or sclerosing agents. This procedure is much safer, effective and consumes less time in comparison to conventional balloon occluded retrograde transvenous obliteration (BRTO) and modified BRTO [12]. In cases with difficult shunt angles, large or small shunt or prominent tortuosity of vessels, CARTO provides a better alternative and is more beneficial than the use of conventional balloons or plugs.

50 years old, known diabetic, chronic liver disease (MELD score 12) with HCV male patient presented with complaint of melena (7 to 8 episodes) and hematemesis 1 episode over the last 2 days. Previous

endoscopy 9 months earlier had shown grade 2/3 lower esophageal varices and 5 bands had been applied. Note had been made of a large fundal varix but no treatment was attempted. On the current endoscopy, eradicated esophageal varices were noted along with the previously seen large fundal varix and small erosions with mild portal gastropathy. Histoacryl 2 cc was injected but the bleeding was not controlled. A CT scan was performed which confirmed the endoscopic findings of large gastric fundal varices and the presence of a large gastrorenal shunt. The patient was referred to IR for retrograde transvenous obliteration of the gastric fundal varices. Literature review suggests that CARTO appears to be a safe, feasible and effective treatment option for the treatment of portal hypertensive variceal bleeding, including gastric, duodenal, jejunal, stomal, and rectal varices [12, 13].

The procedure was performed under general anaesthesia. An 8 Fr multipurpose (Cook - Flexor Ansel) sheath was sited *via* the right IJ and a venogram was performed using a 5Fr C2 catheter positioned within the left renal vein. This outlined the shunt from the left renal vein to the gastric fundus and a note was also made of a proximal stenosis which was crossed with a microcatheter (Progreat) and then advanced distally towards the fundal varix. Embolization was performed using a glue/lipoidal mixture (1 in 4 concentration) with care taken not to reflux the glue towards the liver or spleen until complete stasis was achieved.

The subsequent venogram showed another large varix fed *via* the same renal shunt. This time the 5F Vert catheter was left in place and the same microcatheter reinserted *via* a second 5 Fr Vert placed *via* a new access site from the right groin. The microcatheter was taken distally into the second large varix. Multiple 0.035' coils (14 mm and 12 mm) were placed *via* the 5 Fr Vert catheter (*via* the jugular access) to close the renal shunt and prevent retrograde flow towards the renal vein while sclerotherapy was performed with an STS foam (1:2:3 mixture of lipoidol, STS and air) mixture *via* the microcatheter.

Finally, CBCT (cone beam CT) was performed to confirm the adequate dispersal of STS and embolization of the fundal varices. No immediate postprocedural complications were seen. Thus, successful glue embolization, STS sclerotherapy and coil-assisted retrograde transvenous obliteration of the gastric fundal varices was performed (**Figs. 3-7**).

Fig. (3): MIP coronal image showing renal shunt and gastric fundal varices.

Fig. (4): Post lipiodol glue embolization.

Transjugular Hepatic Biopsy

Transjugular liver biopsy (TJLB), a method first described and performed on humans in 1967 [14], is an efficient and safe procedure for sampling liver tissue through a jugular approach when ascites or resistant coagulopathy limit the percutaneous approach carrying the risk of life-threatening hemorrhage. This is especially indicated in those patients who have low platelet counts which is a known finding in cirrhotic patients and which is also difficult to correct. Conditions including fulminant or alcoholic hepatitis [15], acute liver failure of unknown cause, in recipients of bone marrow transplant having deranged liver function

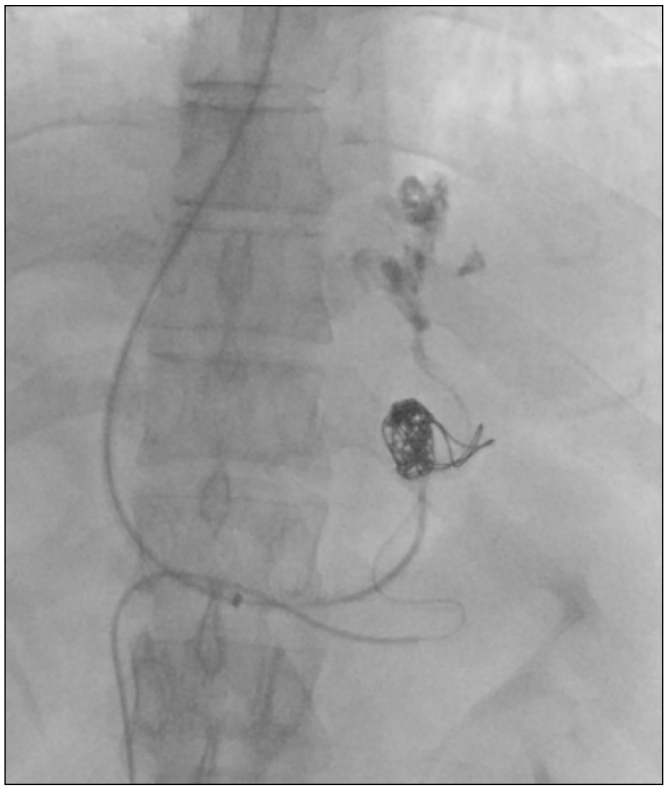

Fig. (5): Coils placed prior to STS.

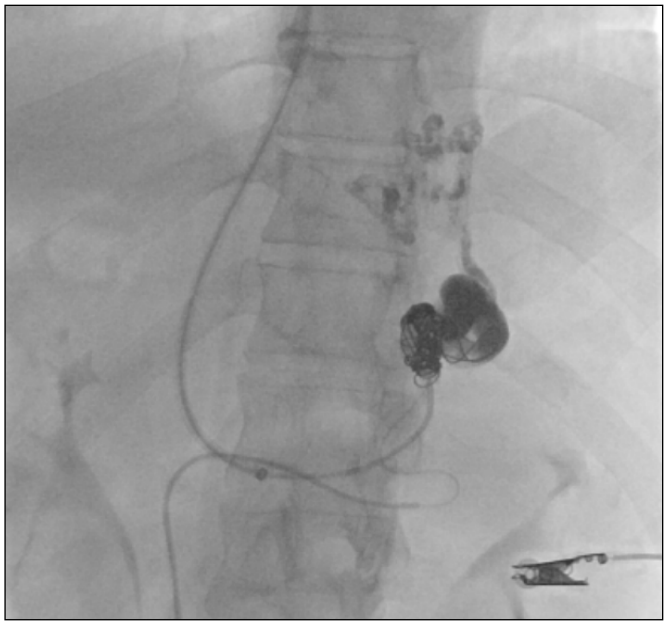

Fig. (6): Post STS after coils.

tests [16], suspicion of idiopathic portal hypertension or concurrent renal biopsy are described possibilities where TJLB is the preferred choice.

A 59-year-old female with deranged LFT and deranged INR was referred to IR for transjugular hepatic biopsy. A 5 Fr vertebral catheter and glide wire combination were advanced into the right atrium, IVC and right hepatic vein. Venography was performed to confirm the catheter position in the right hepatic vein. Amplatz wire was placed in the right hepatic vein and the catheter was removed. 5Fr sheath upsized to 9Fr sheath. The 7Fr guiding sheath of the transjugular biopsy set (Cook) was introduced and placed into the right hepatic vein. Biopsy performed with 19G Transjugular biopsy needle. Three passes were made and full cores were obtained **(Figs. 8A&B)**. No immediate complications were seen on the final hepatic venogram obtained.

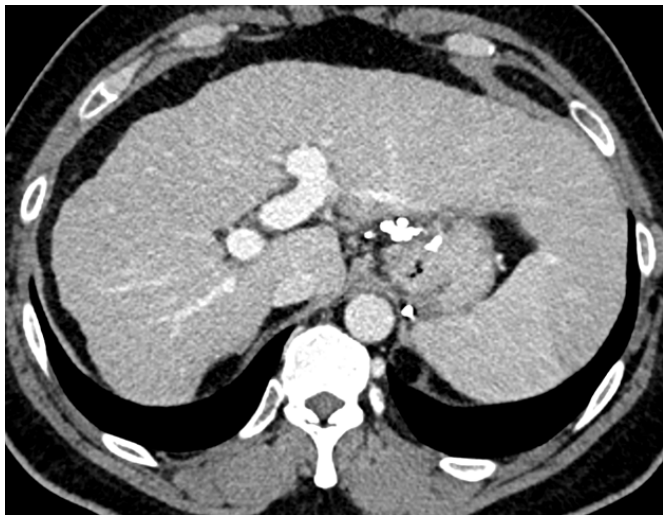

Fig. (7): 3 month followup CT shows embolic material and obliteration of shunt and varices.

Sharp Hepatic Vein Recanalization

This is a more aggressive technique involving the use of sharp wires such as 0.14" or 0.18" calibre guidewires or the back end of a 0.35" hydrophilic guide wire. These techniques are only applied once conventional means of crossing the occlusion have been exhausted and when the occlusive segment is web-like or very short which is usually seen in the setting of Budd Chiari syndrome patients [17]. It has also been applied for chronic total occlusions involving peripheral arteries, and coronary arteries and also for chronic venous occlusive diseases [18].

32 years old female with a history of budd chairi syndrome was referred to IR for sharp hepatic vein occlusion. A venogram was performed using a pigtail catheter in IVC that showed patent IVC with no inflow from hepatic veins. The middle hepatic vein was punctured *via* percutaneous approach and multiple attempts with the front end of the glide wire to negotiate the stenosis were unsuccessful. The glide wire-angled tip catheter combination was successfully negotiated into IVC. Overlapping angioplasty of the stenotic part of the hepatic vein was performed with a 10 x 40 mm balloon. The final venogram showed adequate flow across the IVC. No immediate post-procedure complications were noted (**Fig. 9**).

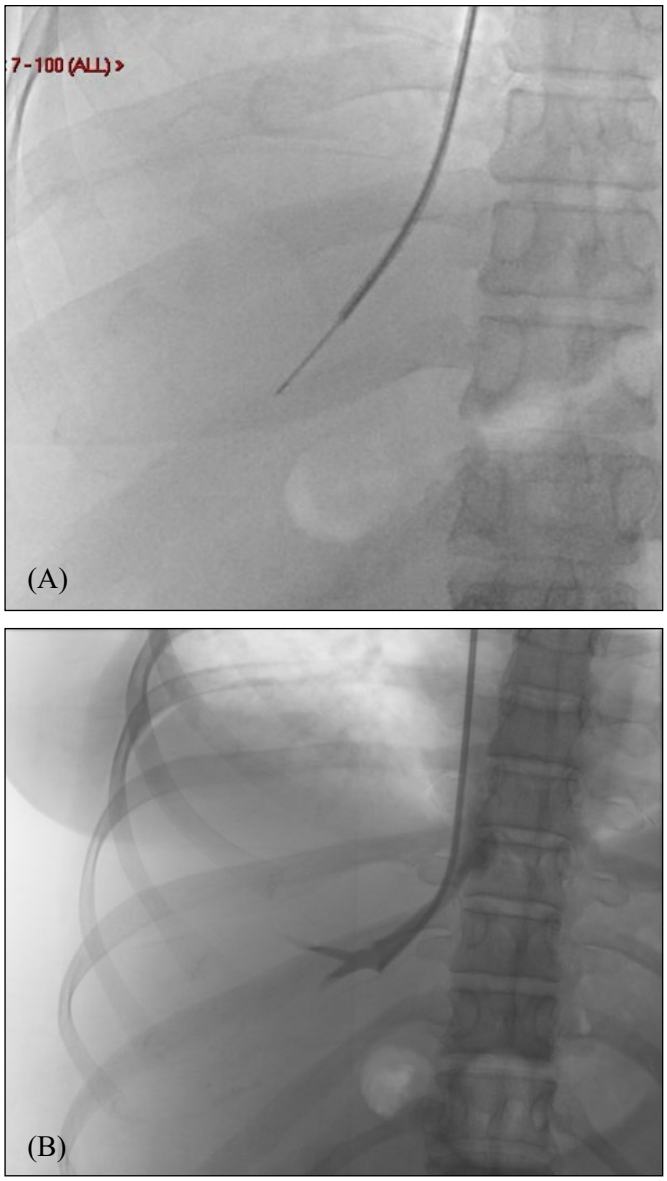

Fig. (8): (A and B): Transjugular biopsy set placed into the right hepatic vein).

Portal Vein Embolization for Remanant Liver Hypertrophy

Partial hepatectomy remains the gold standard curative method for contained primary or metastatic tumours with the evolved focus now on future liver remnants (FLR). Liver regeneration methods are more focused on preventing liver failure post hepatectomy. PVE has become an accepted method for depriving tumoral tissue of blood supply and promoting healthy hepatic tissue hypertrophy following domains of hepatic segments. Thus, acquaintance with portal vein and hepatic segmental anatomy is essential for the procedure [19, 20]. This allows patients to benefit from curative surgical resections and avoid liver transplantation.

66 year old male, with TACE-treated HCC in the right lobe was referred to IR for portal vein embolization. Under ultrasound guidance, the right portal vein segment VI branch was punctured with the needle from a Neff percutaneous access set (Cook Medical) and replaced with the 6 Fr coaxial sheath from the set. A C2 catheter advanced through the sheath and placed into the main portal vein. A portogram was performed to delineate the portal venous anatomy. Then C2 catheter was used to access the segment VII and VIII portal branches and embolization was performed with glue (NBCA) mixed with lipiodol. Embolization of segment V and VI portal branches was performed similarly with glue and lipiodol. A total of 0.5 cc Histoacryl and 2.0 cc Lipiodol was injected. Only coil embolization of the segment IV branch of the left portal vein was performed using a 7 x 3 mm coil (Tornado-Cook). Complete embolization of the segment IV branches with glue and lipiodol could not be done as these branches were very close to their origin from the LPV. Post embolization portogram showed no contrast flow into the embolized portal vessels **(Figs. 10A&B)**. Thus, successful right portal vein and segment IV portal branches embolization was performed.

Hepatic Venous Pressure Gradient

The gold standard tool in diagnosing portal hypertension is hepatic venous pressure gradient which plays an imminent role in treatment selection and is one of the BCLC criteria used in the staging of liver disease, assessing the treatment response and risk stratification. Portal hypertension is defined to be a rise in HVPG

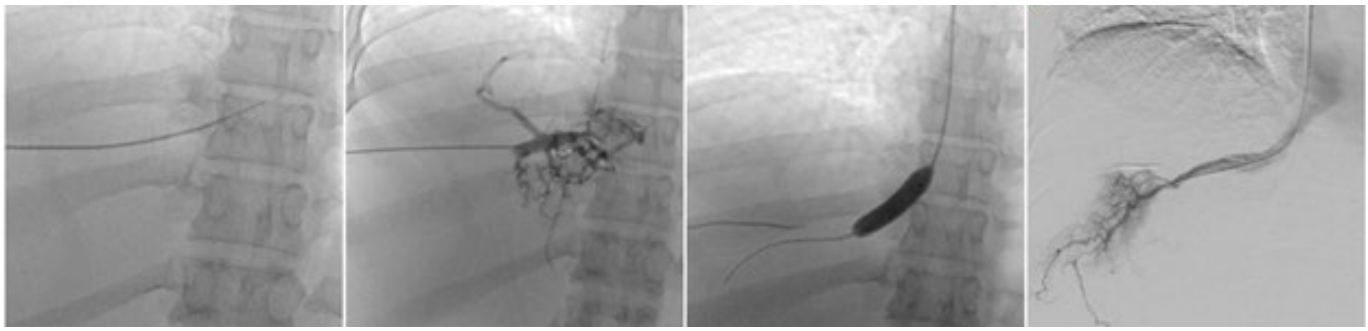

Fig. (9): Hepatic venous occlusion successfully crossed *via* sharp venous recanalization followed by venoplasty.

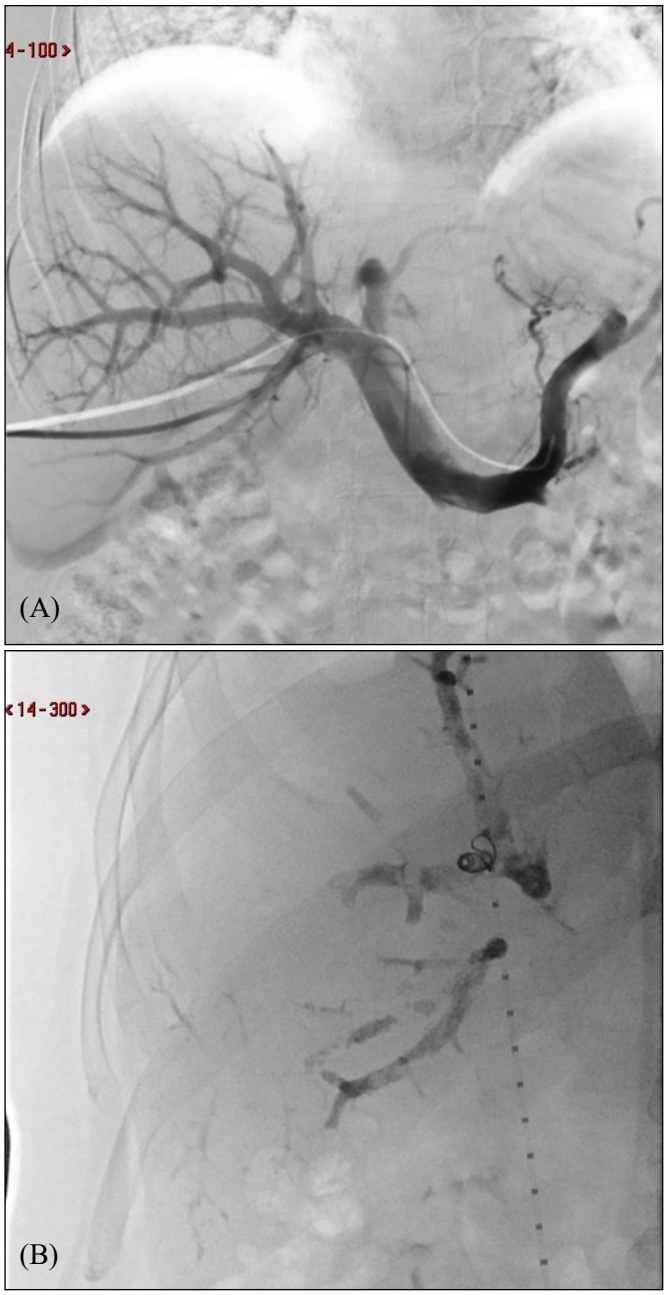

Fig. (10): (A and B): Percutaneous access to portal vein confirmed by angiogram followed by injection of embolic material into portal vein.

above 5 mm of Hg but complications are mostly seen when it is above 12 mm of Hg [21]. According to the European Association for the Study of the Liver (EASL) and American Association for the Study of Liver Diseases (AASLD) guidelines for managing HCC, HVPG rises to equal or more than 10 mm Hg to be a contraindication for liver resection [22, 23]. This is due to the increased risk of liver decompensation postoperatively in accordance with the reports given by Barcelona Clinical Liver Cancer (BCLC) [24].

The known HBV with CLD was referred to IR for HVPG measurement. Access was done through a right internal jugular vein with a 5 Fr sheath. A 5 Fr Bern catheter was used. Pressures were measured with an angle tip catheter.

Recorded pressures were:

Right atrium: -1 mm of Hg

Hepatic vein wedge pressure: 21 mm of Hg

Free Hepatic vein pressure: 9 mm of Hg

Gradient: 12 mm of Hg

Thus, this gradient of 12 mm of Hg represents clinically significant portal hypertension (**Fig. 11**). The patient is not suited for surgical resection despite meeting the other criteria outlined in the BCLC guidelines and measuring his portal pressure proved pivotal in his management as he would decompensate if surgical resection was performed.

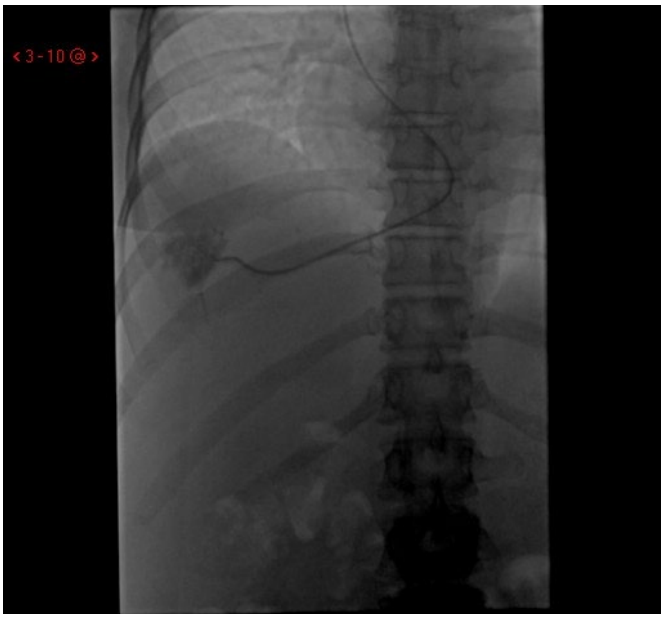

Fig. (11): Hepatic venous pressure measurement on DSA.

CONCLUSION

The minimally invasive procedures used by IR are helpful in not only diagnosing but also managing the complications of portal hypertension both in the emergency setting and in the setting of chronic venoocclusive disease with the emergence of second-generation stents. In addition, portal vein embolisation allows some patients to receive curative surgical resection who would otherwise need liver transplantation. These newer treatment options continue to evolve and are sharing the healthcare burden in a developing country like Pakistan.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

FUNDING

Declared none.

ACKNOWLEDGEMENTS

Declared none.

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