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Plug-assisted Retrograde Transvenous Obliteration (PARTO) for Gastric Variceal Bleeding in Left-sided Portal Hypertension: An Institutional Case Series

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ABSTRACT

Purpose: This case series aims to evaluate the procedural safety and clinical outcomes of plug-assisted retrograde transvenous obliteration (PARTO) in patients presenting with severe upper gastrointestinal bleed secondary to left sided portal hypertension (LSPH) following unsuccessful conservative and endoscopic management.

Material and Methods: The study includes 4 patients presenting with acute upper gastrointestinal bleed and LSPH. Pre-procedural imaging workup was performed to confirm the presence of gastro-renal shunt and rule out high-risk anatomical factors. After failure of endoscopic management, PARTO was performed with subsequent gel-foam embolization of the gastric varices. Post-procedural outcomes were noted at 1 month and 3 months.

Results: All four patients showed significant clinical improvement post procedure with no recurrent bleeding. On 1 month and 3 months follow up, one patient experienced progression in ascites and another patient progression in esophageal varices requiring endoscopic banding at 2 months. All patients had reduction in size of gastric varices at 3 months follow up endoscopy. Overall PARTO demonstrated high clinical success rate with minimal complications.

Conclusions: PARTO has emerged as a safe and promising solution treating gastro-variceal bleed secondary

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to left-sided portal hypertension and gastro-renal shunt draining anatomy, particularly after failed endoscopic management. The technique has high clinical success rate, good short term clinical outcome and associated with minimal complications.

Keywords: Gastric varices, Left-sided portal hypertension, Vascular plug, Embolization, Gastro-renal shunt.

Introduction

Left-sided portal hypertension (LSPH), also known as sinistral hypertension, is a rare condition that is often misdiagnosed as generalized (right-sided) portal hypertension. Most patients are asymptomatic or have vague abdominal pain, whereas others present with life-threatening upper gastrointestinal (UGI) bleeding. They are detected incidentally on imaging or while investigating for unexplained UGI bleeding or splenomegaly. The overall incidence of LSPH is less than 5% in all patients with portal hypertension [1]. As most patients are non-cirrhotic (80%), ascites is rarely seen unless they have concomitant dilutional hypoalbuminemia of any etiology. Spleno-portal venous obstruction (secondary to thrombosis, chronic pancreatitis, pancreatic pseudocysts, and pancreatic neoplasms) is often the main pathophysiological factor in the development of gastric varices. A progressive increase in left-sided portal pressure leads to shunting of blood from the spleen to the short gastric veins (posterior gastric, left gastric, and superior gastric veins). Gastric varices that develop in the fundal region are more lethal at presentation than esophageal varices, and have a higher tendency to bleed with poor patient outcomes [2,3,4]. These patients often face anatomical limitations that make traditional endoscopic interventions difficult and less effective, particularly in cases with large varices or poor visibility during severe bleeding.

Vascular plug-assisted retrograde transvenous obliteration (PARTO) is emerging as safe, minimally invasive alternative for patients in whom conservative and endoscopic management has failed. The technique involves deploying a vascular plug in the gastro-renal shunt, followed by gel foam embolization of gastric varices. This is a case series of 4 patients presenting with gastro-variceal bleeding secondary to left-sided portal hypertension, all of whom underwent successful PARTO after unsuccessful endoscopic management.

Material and Methods

Patient selection: This is a retrospective study on 4 patients conducted between May 2023 and May 2024. All patients underwent pre- and post-procedural imaging with contrast-enhanced computed tomography (CT).

Pre-procedural evaluation: A thorough anatomical evaluation of gastro-renal shunt using computed tomography is recommended with importance given to the following parameters (Fig 1): (a) minimum and (b) maximum diameter of GRS proper, (c) diameter of common stump of adrenal vein and GRS proper, (d) shunt distance from the left renal vein origin (e) Left renal vein diameter, (f) Left renal vein and shunt orientation and angulation.

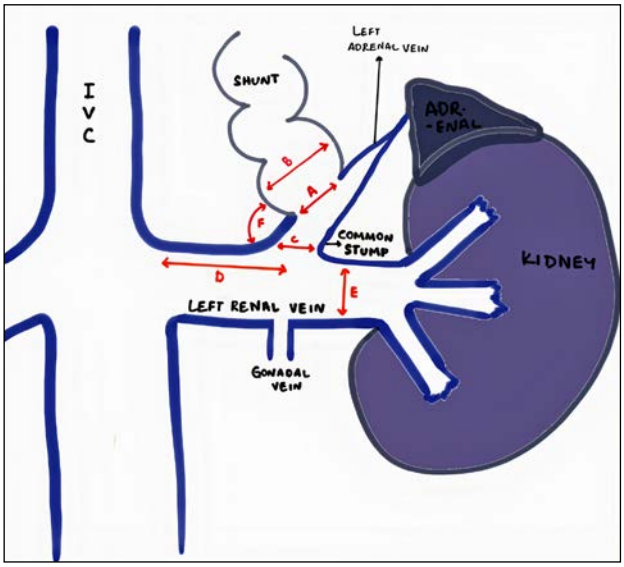

Fig. 1: *Illustrative diagram of gastro-renal shunt: (A) minimum and (B) maximum diameter of GRS proper, (C) diameter of common stump of adrenal vein and GRS proper, (D) shunt distance from the left renal vein origin (E) Left renal vein diameter.*

Aneurysmal dilatation of the left renal vein (diameter greater than 50% of the normal calibre or an unaffected segment), unfavourable shunt angulation (either too acute <60 or obtuse >120), and out-of-plane orientation of shunt origin with LRV (anterior/posterior directed) were identified as significant risk factors for procedural failure [5].

This evaluation minimizes procedural risks, improves technical success, and enhances the likelihood of achieving effective variceal obliteration.

PARTO technique

The procedures were performed under local anesthesia, and all four patients underwent right femoral venous access. Gastro-renal shunt was accessed via the left renal vein and common stump (with adrenal vein) using 5Fr Cobra or Simmons Angio catheter with 180cm 0.035' guide wire (Terumo, Tokyo, Japan). An appropriately sized 7-10Fr Long Vascular sheath (Flexor Check-Flo or shuttle sheath; Cook, Bloomington, IN, USA) is selected based on the size of the vascular plug for deployment. The size of the vascular plug device was determined after appropriately upsizing it by 30-50% relative to the narrowest part (waist) of the gastro-renal shunt. Long vascular sheath was wedged in the common adrenal vein or GRS over a 260cm, 0.035-inch Amplatz Extra-Stiff guidewire (Cook, Inc) for vascular plug deployment and a 2.7Fr microcatheter (Direxion, Boston Scientific, Natick, MA) was placed distal to the plug for variceal embolization. In cases of difficult or tortuous anatomy, the sheath can be advanced into the GRS using two 0.035 guidewires. Amplatzer Vascular Plug Type II (AGA Medical, Golden Valley, MN, USA) was used in all the patients (Fig 2). Retrograde venography is performed using the long sheath placed inside the GRS after occluding the common adrenal vein/GRS with a vascular plug. Anatomy of GRS, dominant collateral veins, efferent and afferent pathways were delineated on venography. After confirming appropriate occlusion of the GRS by microcatheter venography, gastric variceal embolization was performed using a combination of contrast and gel-foam pledgets injected through the same microcatheter. The endpoint of embolization was complete opacification of gastric varices on fluoroscopy with slow opacification and visualization of the left gastric vein or posterior gastric vein (Fig 3). In situations where a number of collateral veins, including the pericardiophrenic, inferior diaphragmatic, and intercostal veins, are efferent feeders, gel foam can be slowly injected intermittently with contrast to ensure stasis and occlusion of these veins.

Case 1:

A 47-year-old female patient presented to the emergency department with a 5-day history of giddiness and vomiting along with massive hematemesis that occurred few hours back. Hematemesis was likely secondary to severe retching, leading to upper gastrointestinal bleed-

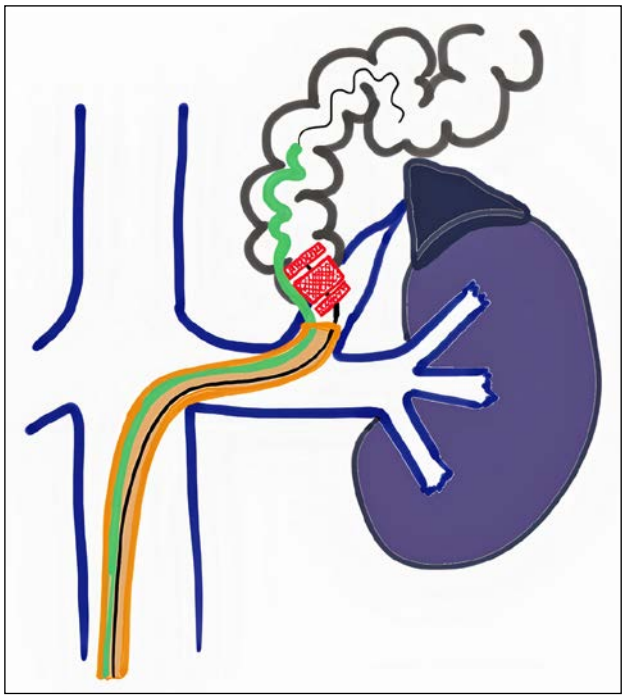

Fig. 2: *Illustrative diagram of vascular plug deployment (red) across the waist of the gastro-renal shunt proper using long sheath (orange). A jailed microcatheter (green) is placed distal to the plug for gastric variceal gel-foam embolization.*

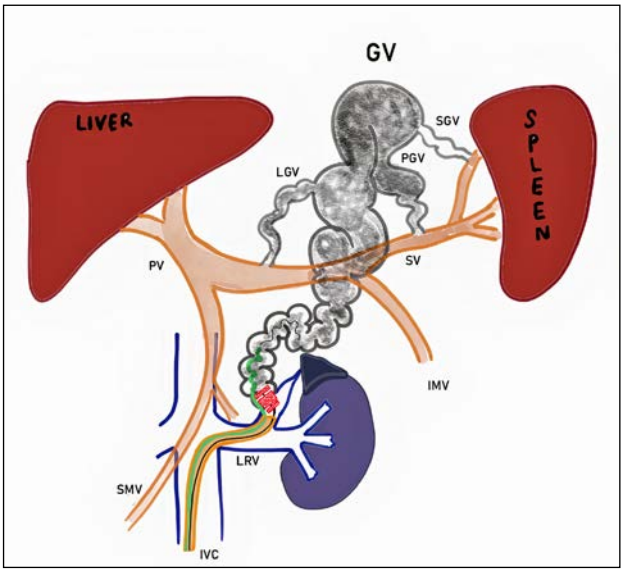

Fig. 3: *Illustrative diagram of PARTO demonstrating vascular plug deployment at the gastro-renal shunt with gel-foam embolization of gastric varices (GV). The end point variceal embolization (PARTO/BRTO) is gradual visualisation of left gastric/ posterior gastric veins. (PV: Portal vein; SV: splenic vein; IMV: inferior mesenteric vein; SMV: superior mesenteric vein; LGV: left gastric vein: PGV: posterior gastric vein: SGV: superior gastric vein; LRV: left renal vein; IVC: inferior venacava).*

ing. The patient was severely anemic (hemoglobin: 6 g%), with a heart rate of 110bpm and blood pressure of 90/56 mmHg. In addition, there was a history of severe mitral regurgitation and anemia, which may have contributed to the patient's symptoms. The patient's vital signs were initially stabilized with blood transfusions and emergency endoscopy was planned. After failure of endoscopic management due to a difficult anatomy and poor field of vision due to massive hemorrhage, the patient was referred to the interventional radiology department for the modified BRTO/PARTO procedure. Preprocedural computed tomography was performed to confirm and delineate the anatomy of the gastro-renal shunt. On CT images, isolated gastric varices were noted predominantly draining into the left renal vein with a waist size of 9.2 +/- 0.5 mm. A 14 mm Amplatzer Vascular Plug Type II (AGA Medical, Golden Valley, MN, USA) was deployed across the waist (narrowest part) of the GRS. Retrograde venography was performed to confirm adequate occlusion of the gastro-renal shunt, and gastric variceal embolization was performed using a combination of contrast and gel foam pledgets. (Fig 4). The patient's vital signs were monitored. The patient remained asymptomatic during the rest of the hospital stay with improving

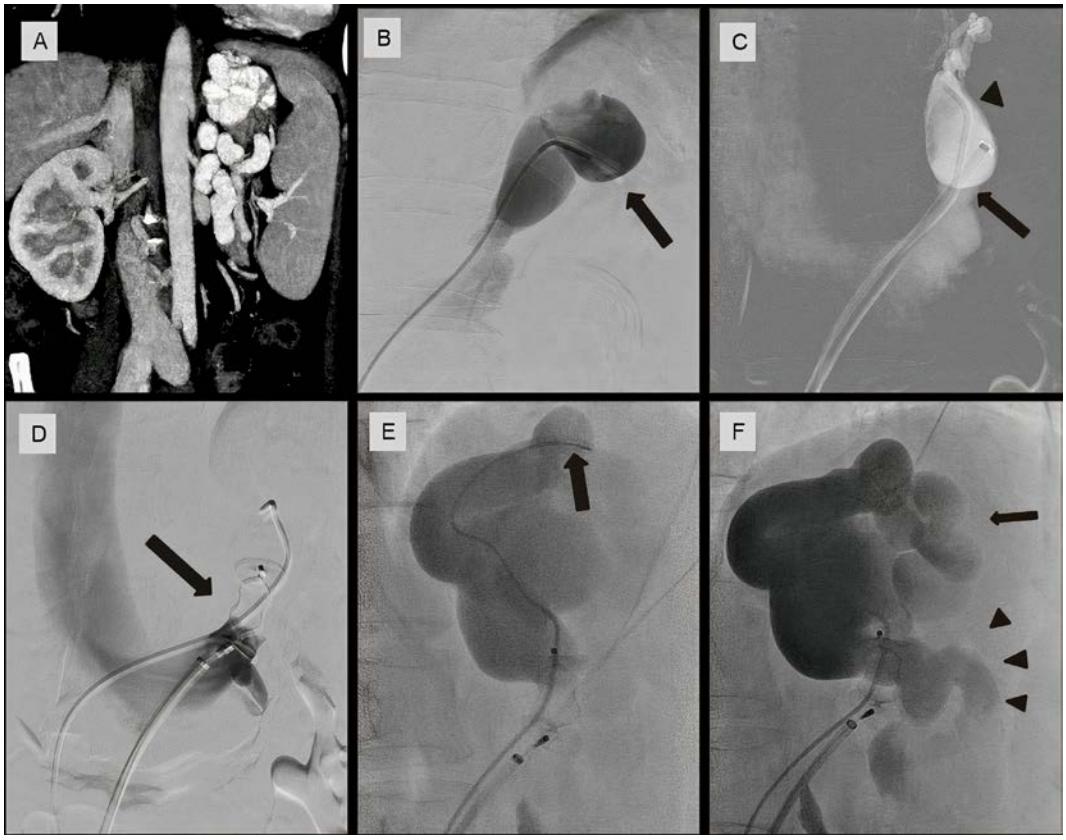

Fig. 4: *A. Post contrast CT coronal section showing isolated gastric varices with splenomegaly (left-sided portal hypertension).*

B. Placement of 4Fr diagnostic catheter in the gastro-renal shunt and its position confirmed by a check venogram.

C. Placement of Long sheath (arrow) at the origin of gastro-renal shunt. Common stump with adrenal vein tributaries are seen in profile (arrow head).

D. Deployment of vascular plug type II across the waist of the gastro-renal shunt (arrow) and check venogram demonstrating complete occlusion the gastro-renal shunt. Microcatheter placement inside the gastric varices.

E. Slow embolization of gastric varices a the microcatheter with gel-foam and contrast.

F. Complete visualization of gastric varices with slow opacification of posterior gastric vein. Procedure was concluded at this point.

haemoglobin levels. Follow-up endoscopy and computed tomography were performed at 1 month, which showed a significant decrease in gastric varices with no recurrence of symptoms or gastrointestinal bleeding.

Case 2:

A 45-year-old male patient with history of decompensated chronic liver disease secondary to chronic alcoholism presented to the emergency department with recurrent episodes of hematemesis which increased from the last 2 days. The patient's haemoglobin was 8.9 g%, had mild tachycardia (82 bpm) but otherwise vitally stable (blood pressure 110/80mmHg). The patient had undergone failed endoscopic glue embolization of gastric varices on two separate occasions in the last 3months. On CT images, a large isolated gastric varix was noted draining via the gastro-renal shunt into left renal vein with waist size of 8.6 +/- 0.5mm. The patient was referred to interventional radiology for endovascular management. In the interventional suite, gastro-renal shunt was cannulated via the right femoral venous access. A 12mm sized Amplatzer vascular plug Type II was deployed across the shunt and subsequent gastric variceal embolization was done using gel-foam and contrast (Fig 5). Post procedure the patient developed low grade fever which was alleviated with antipyretic medications. The patient recovered well the next day with no fresh episodes of bleeding in the remainder of the hospital stay.

Fig. 5: *A. Post contrast CT coronal sections showing isolated gastric varices with splenomegaly (left-sided portal hypertension).*

B. Placement of 4Fr diagnostic catheter in the gastro-renal shunt and its position confirmed by a check venogram.

C. Deployment of vascular plug type II across the waist of the gastro-renal shunt and check venogram to confirm complete occlusion the gastro-renal shunt.

D. Left oblique view of gastric varices with gel-foam and contrast.

E. AP view of gastric varices with gel-foam and contrast.

F. Faint visualization of left gastric vein (red arrow) with stasis of contrast in the gastric varices.

Case 3:

A 29-year-old young male patient presented to the outpatient department with 2-day history of hematemesis, melena and decreased bowel movements. Ultrasonography was performed which revealed shrunken liver with portal hypertension, splenomegaly and mild ascites. CT revealed large tortuous varices in the gastric fundus region.

In view of difficult anatomy for endoscopic management, patient was referred to interventional radiology. A 14mm sized Amplatzer vascular plug Type II was deployed across the shunt, relative to GRS waist size of 9.0 +/- 0.5mm. Gastric variceal gel-foam embolization was performed (Fig 6). Post procedure was uneventful and patient recovered well.

Case 4:

A 56-year-old male patient presented to the emergency department with intermittent hematemesis since the last 2days. The patient was a known case of chronic parenchymal liver disease and had undergone endoscopic esophageal banding twice in the last one year.

Emergency endoscopy was performed and large gastro-esophageal varices were visualised. Subsequently glue embolization was performed. The patient recovered well for two days but presented again with he-

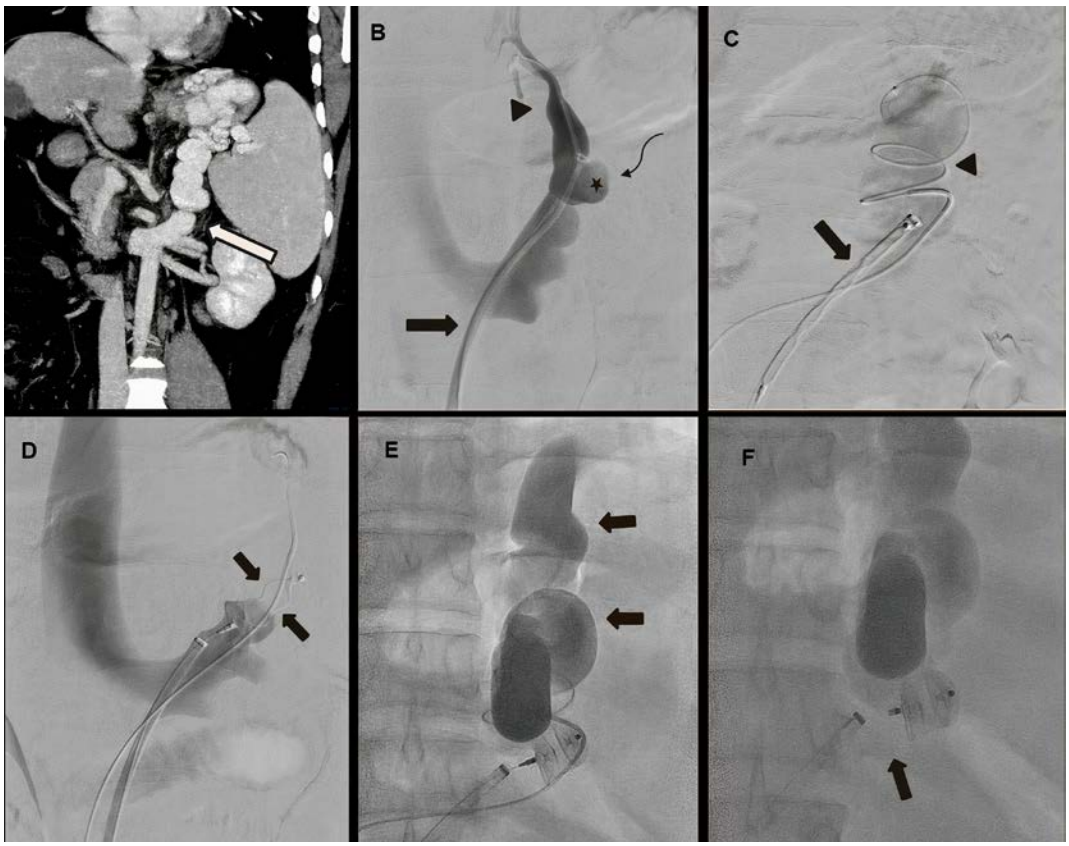

Fig. 6: *A. Post contrast CT coronal images showing isolated gastric varices with splenomegaly (left-sided portal hypertension)*

B. The GRS commonly does not empty directly into the left renal vein (LRV) but actually empties in the LRV via a common stump with the left adrenal vein (black arrow).

C. Identification of GRS by rapid washoff of contrast along the lateral wall of the common stump (asterisk).

D. Deployment of vascular plug type II across the waist of the gastro-renal shunt (red arrow) and check venogram demonstrating complete occlusion the gastro-renal shunt. Microcatheter placement inside the gastric varices (yellow arrow)

E. Slow embolzation of gastric varices a the microcatheter with gel-foam and contrast.

F. Complete visualization of gastric varices with stasis of contrast,

matemesis. The patient was referred to interventional radiology for further management. CECT abdomen was performed which revealed large gastro-esophageal varices (GOV type 2) with gastro-renal shunt as dominant drainage pathway. Patient was immediately transferred to interventional suite. A 14mm sized Amplatzer vascular plug device Type II was deployed across the shunt, relative to GRS waist size of 10 +/- 0.5mm. Gastric variceal gel-foam embolization was performed. Patient recovered well after the procedure.

Post Procedure Follow Up

All 4 patients were followed up at 1 month and 3 months to evaluate gastro-renal shunt occlusion and for any procedure related complications such as hematoma or systemic thrombosis. Progression in size of esophageal varices or appearance of any other ectopic varices were evaluated with endoscopy and computed tomography, upon the discretion of the treating physician. Median interval of endoscopy from the procedure was at 1 month. All 4 patients had symptomatic improvement and significant reduction in size of the gastric varices on endoscopy and computed tomography. Two patients had complete resolution and other two patients had significant reduction in size of gastric varices. One patient underwent banding for esophageal varices at 2 month follow up period. One patient had progression in ascites at 1 month follow up. Medical tests were done at 1 month and 3 months to look for changes in liver function tests or signs of recurrent bleeding, which revealed no significant interval changes.

Discussion

Variceal bleeding is fairly common and dreaded complication of portal hypertension. Gastric varices appear in 20-30% of patients with cirrhosis and portal hypertension. While the exact mortality rates vary across studies, gastric variceal bleeding is associated with significant mortality and morbidity ranging between 8% and 35% depending on the treatment approach and follow-up period [6,7]. Gastric varices are less common than esophageal varices, but they are more severe at presentation which can rupture and result in massive gastrointestinal bleeding requiring timely and effective interventions for the survival of the patient.

Gastric varices can be classified based on their location, into gastroesophageal varices (GOV) and isolated gastric varices (IGV). Sarin et al.'s classification is the most commonly used to classify gastric varices. Gastroesophageal varices are extensions of esophageal varices and are termed GOV type 1(GOV1) when they extend below the gastroesophageal junction along the lesser curvature, and GOV type 2(GOV2) when they extend into the fundus of the stomach. Isolated gastric varices (IGV) located in the fundus of the stomach are called IGV type 1(IGV1) or commonly referred to as fundal varices. IGV type 2(IGV2) is an ectopic varix located anywhere in the stomach. GOV1 represents almost 75% of all gastric varices, followed by GOV2 (21%), IGV1 less than 2%, and IGV2, which comprises 4% [8].

First line of management of gastric variceal bleed is medical therapy and endoscopic N-cyanoacrylate glue embolization [9,10,11]. Interventional radiology techniques are employed when endoscopy fails, which includes transjugular intrahepatic portosystemic shunt (TIPS) and balloon retrograde transvenous obliteration (BRTO). Of the two, BRTO is preferred in East Asian countries because it is less invasive, cost effective and has a better survival rate.

Plug-assisted retrograde transvenous obliteration (PARTO) is an emerging modification of the BRTO technique for the treatment of gastric variceal bleeding. It involves occlusion of the gastro-renal shunt using a vascular plug device and subsequent embolization of the varices using gel foam or sclerosant. Compared to BRTO, PARTO does not require prolonged overnight balloon inflation and can be performed in a wider range of patients, including those lacking a gastro-renal shunt, and is associated with a lower risk of exacerbation of portal hypertension [12,13,14]. PARTO also mitigates the devastating risk of systemic embolization of sclerosant as seen in conventional BRTO in up to 8.7% of cases [15].

The choice of access can be transfemoral or transjugular approach. If the origin of the shunt is close to the origin of the LRV, it is preferable to use transfemoral approach as it has a steeper angle with the LRV (more perpendicular). If the origin of the shunt is far from LRV origin, a transjugular approach is easier as it has shallower angle with the LRV (more parallel) [16] (Fig 7).

GRS commonly does not drain directly into the LRV, but joins the left adrenal vein to form a common stump before draining to the LRV. It is important to check for a web-like narrowing usually seen at the junction of GRS proper with the common stump. A reverse-shaped

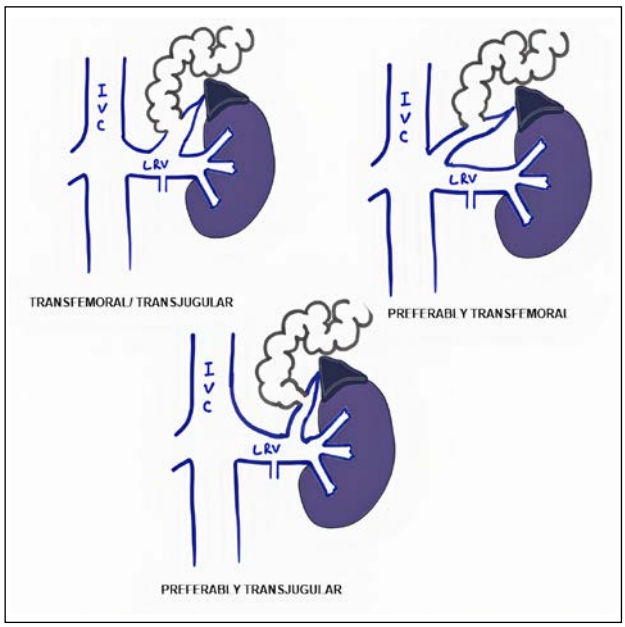

Fig. 7: *Illustrative diagram for access route preference: If angulation of IVC and LRV is between 60 – 1200 , either transfemoral and transjugular route can be used. Use transfemoral approach if it has a steeper angle with the LRV (more perpendicular; > 1200). If the origin of the shunt is far from LRV origin, a transjugular approach is easier as it has shallower angle with the LRV (more parallel; < 600).*

catheter is especially helpful in selection if the common stump or the GRS proper points medially in the 9 to 11 o'clock position. Occasionally, there is little discernible difference between the common stump and the GRS proper.

Aggravation of ascites and esophageal varices are the main drawbacks of PARTO/BRTO and is attributed to increased portal flow [6,17]. A study by Saad et al. reported the protective role of combining TIPS with BRTO in the development of hydrothorax, ascites, and upper gastrointestinal bleeding; however, the concomitant protective effect on the progression of esophageal varices was not evaluated, although theoretically very valid [18]. Modified techniques, such as selective and super-selective BRTO/PARTO, have been employed and have shown a decreased risk of exacerbating ascites and esophageal varices [19]. Shunt occlusion with preexisting partial/complete portal vein thrombosis was a risk factor for aggravation of esophageal varices, whereas the amount of sclerosant employed was found to be a major risk factor for ascites aggravation [19].

PARTO has shown promising results in terms of both short-term and long-term efficacy in treating gastric varices, with a technical success rate of 100% and clinical success ranging from 97.3% to 100% [20]. Complications are generally minor and manageable, with reported rates of adverse events being relatively low compared with other endoscopic or interventional techniques (TIPS). Clinical outcomes have been favorable, with studies reporting high rates of complete variceal obliteration, reduced rebleeding rates, and improved overall survival in patients undergoing PARTO [21, 22, 23].

Conclusion

Gastrovariceal bleed poses a significant clinical challenge owing to its severity and high associated mortality. Plug-assisted retrograde transvenous obliteration (PARTO) has emerged as a safe and effective alternative in failed endoscopic management due to its high technical success rate and favourable outcomes in variceal obliteration. A thorough pre-operative anatomical evaluation helps in planning and selecting appropriate hardware there by enhancing procedural success and patient prognosis. However, a meticulous patient selection with close monitoring and future comparative studies are needed to stand out in clinical practice. **R**

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Conflict of interest: The authors declare that they have no conflict of interest.

Ethical Approval: The study was performed in accordance with the principles of the Declaration of Helsinki and the Institutional Review Board approved this retrospective study.

Informed Consent: The Institutional Review Board approved this retrospective study and waived the requirement of informed consent.

Consent for Publication: Consent for publication was obtained for every individual person's data included in the study.

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KEY WORDS

Gastric varices, Left-sided portal hypertension, Vascular plug, Embolization, Gastro-renal shunt

READY - MADE CITATION

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