Original Article

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Radiology Section

Plug-assisted Retrograde Transvenous Obliteration with or without Partial Splenic Embolisation for Gastric Variceal Bleeding: A Retrospective Study

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ABSTRACT

Introduction: Gastric variceal bleeding is a severe complication of portal hypertension with limited efficacy of endoscopic therapy in patients with large fundal varices or spontaneous shunts. Plug-Assisted Retrograde Transvenous Obliteration (PARTO) offers a minimally invasive alternative by occluding the Gastro-renal Shunt (GRS) and achieving durable variceal control. Partial Splenic Embolisation (PSE) may further lower portal pressure and improve hypersplenism.

Aim: To compare outcomes between PARTO alone and PARTO with PSE, in terms of variceal regression, Oesophageal Varices (EV) progression, and complication rates.

Materials and Methods: A retrospective observational study was conducted in the Department of Interventional Radiology at Dr. D Y Patil Medical College, Hospital and Research Centre, Pimpri, Pune, Maharashtra, India, from May 2023 to May 2025. The study included 20 patients with gastric variceal bleeding secondary to portal hypertension who underwent PARTO or PARTO + PSE after resistant to or failed endoscopic management. Group A (n=15) underwent PARTO alone, and Group B (n=5) underwent PARTO with adjunctive PSE. Technical and clinical success, variceal regression, EV progression, rebleeding, and complications were evaluated. Statistical analysis included Fisher's exact and unpaired t-tests, with significance set at p-value <0.05.

Results: Technical success was achieved in 20/20 patients (100%), and clinical success in 19/20 (95%). Rebleeding occurred in 1 patient (5%), exclusively in the PARTO-alone group. Complete gastric variceal obliteration was observed in 15 patients (75%), with partial regression in 5 (25%). EV progression occurred in 6 patients (30%); 5/15 (33%) in the PARTO group vs 1/5 (20%) in the PARTO+PSE group. Minor complications were more frequent in the PARTO + PSE group (100% vs 33%, p-value=0.04), predominantly the post-embolisation syndrome. Mean hospital stay was numerically longer in the combined group; however, this difference was not statistically significant (9.3±0.8 vs 4.5±1.1 days).

Conclusion: PARTO is a safe and highly effective treatment for gastric variceal bleeding refractory to endoscopic therapy, achieving high technical and clinical success with low rebleeding rates. Adjunct PSE may offer haemodynamic modulation in selected patients with hypersplenism/splenomegaly, but was assosciated with higher post-procedural morbidity and longer hospital stay without a statistically significant outcome benefit.

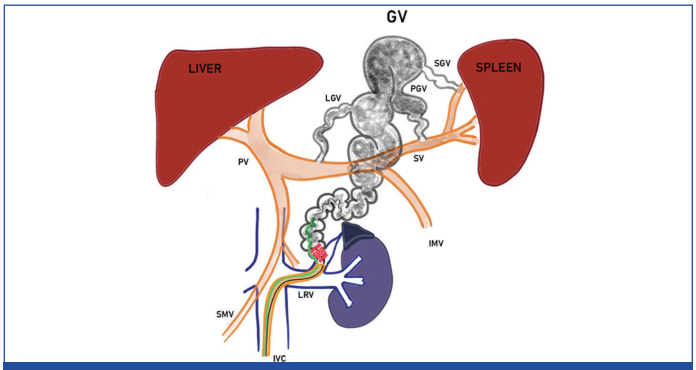
Keywords: Endoscopy, Hypersplenism, Portal hypertension, Recurrence, Thrombocytopenia

INTRODUCTION

Gastric variceal bleeding is a life-threatening complication of portal hypertension, accounting for 16-45% of all variceal bleeds [1]. Gastric varices that develop in the fundal region are more lethal at presentation than oesophageal varices, and have a higher tendency to bleed with poorer outcomes and higher mortality ranging between 8-35% [1,2]. First-line management of gastric variceal bleed includes medical therapy and endoscopic glue embolisation; however, outcomes are often limited by large variceal size, complex anatomy, and poor visualisation during active bleeding [1,3]. Interventional radiology options for refractory gastric varices include Transjugular Intrahepatic Porto-systemic Shunt (TIPS) and Balloon or PARTO techniques (BRTO and PARTO) [1,3].

The PARTO has demonstrated high technical and clinical success rates with favourable outcomes and reduced complications compared with traditional BRTO [3-5] [Table/Fig-1]. Partial Splenic artery embolisation (PSE) is an adjunct procedure aimed at decreasing splenic blood flow and portal venous pressure, thereby reducing rebleeding rates and improving platelet counts in hypersplenism [6,7]. However, it is associated with post embolisation syndrome (transient fever, nausea, pain, leukocytosis) leading to prolonged hospital stay [8].

The present study substitutes balloon-based BRTO with PARTO, preserving the haemodynamic advantage while avoiding balloon-related limitations, along with comparing the potential adjunctive role of partial splenic embolisation in combination with PARTO, for which limited comparative data are available. Hence, the present study compares the outcomes of PARTO alone versus PARTO combined with PSE in managing gastric variceal bleeding in patients with portal hypertension.



[Table/Fig-1]: Illustrative diagram of PARTO demonstrating vascular plug deployment at the GRS with Gelfoam embolisation of Gastric Varices (GV). The endpoint of any embolisation (PARTO/BRTO) is gradual visualisation of the 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

MATERIALS AND METHODS

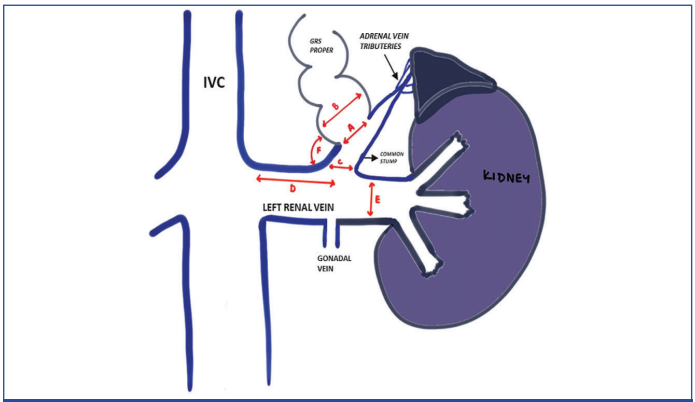
A retrospective observational study was conducted in the Department of Interventional Radiology at Dr. D Y Patil Medical College, Hospital and Research Centre, Pimpri, Pune, Maharashtra, India, from May 2023 to May 2025. The study included 20 patients with gastric variceal bleeding secondary to portal hypertension who underwent PARTO or PARTO + PSE after resistant/failed endoscopic management. Institutional Ethics Committee approval/ waiver was obtained for this retrospective study.

Inclusion criteria: Patients with active or recent gastric variceal bleeding confirmed on endoscopy, who have failed or experienced recurrent bleeding after endoscopic glue embolisation, and demonstrate a spontaneous portosystemic shunt (such as gastro-renal or gastrocaval) on Computed Tomography (CT) imaging were included.

Exclusion criteria: It included the absence of accessible venous drainage for a retrograde approach, complete portal vein thrombosis with cavernoma formation, and decompensated hepatic failure defined by a Child-Pugh score greater than 12.

Study Procedure

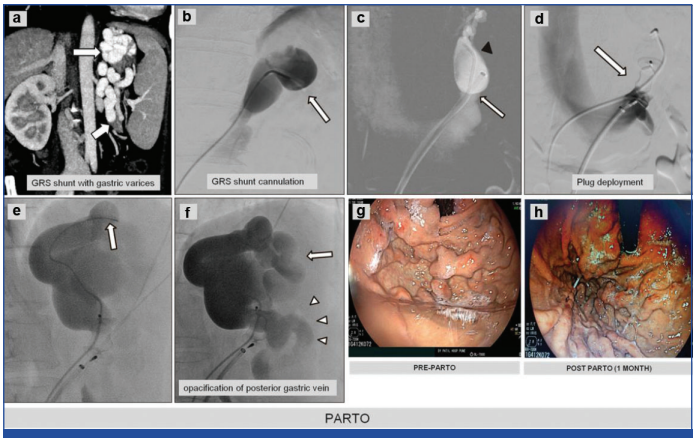
Preprocedural imaging: A thorough preprocedural anatomical evaluation of the GRS using CT was performed [Table/Fig-2]. Aneurysmal dilatation of the left renal vein (diameter greater than 50% of the normal calibre or an unaffected segment), unfavourable shunt angulation (either too acute <60 or obtuse >120), and out-of-plane orientation of shunt origin with LRV (anterior/posterior directed) were identified as significant risk factors for procedural failure [4]. This evaluation minimises procedural risks, improves technical success, and enhances the likelihood of achieving effective variceal obliteration.



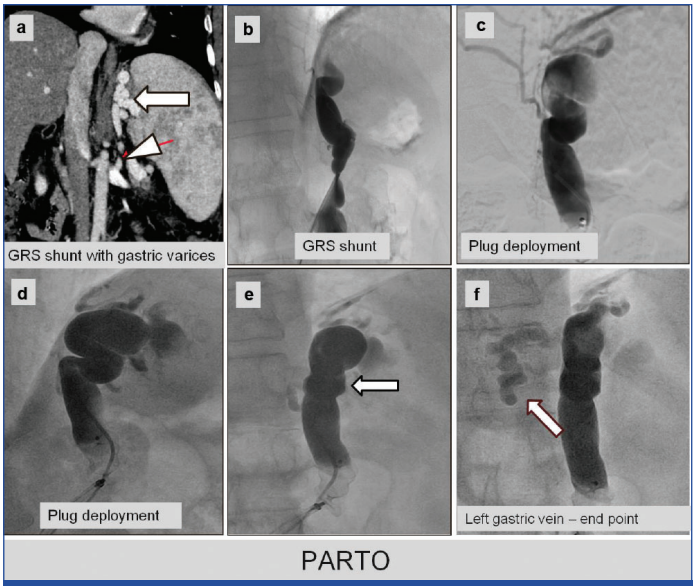
[Table/Fig-2]: Illustrative diagram of gastro-renal shunt: (A) Minimum and (B) Maximum diameter of GRS proper, (C) Diameter of common stump of adrenal vein and GRS proper, (D) Shunt distance from the left renal vein origin (E) Left renal vein diameter (F) Left renal vein and shunt orientation and angulation.
GRS: Gastro-renal shunt. IVC: Inferior vena cava

Procedural Technique: All procedures were performed under local anaesthesia/ conscious sedation, under fluoroscopic guidance with post procedure monitoring for 48–72 hours.

Group A – PARTO (n=15): In most patients, right common femoral venous access was used [Table/Fig-3,4]. However, in one patient a transjugular approach was initiated due to a congenitally absent right common femoral vein. The left renal vein and GRS were catheterised using a 5Fr Cobra or Simmons catheter. A 7–10Fr long vascular sheath (Flexor Check-Flo or shuttle sheath; Cook, Bloomington, IN, USA) is selected based on the size of the GRS and advanced up to the narrowest part of the shunt. In cases of difficult or tortuous anatomy, the sheath can be advanced into the GRS using two 0.035 super-stiff guidewires (Cook, Inc). Left femoral venous access was taken and another 4Fr Cobra or Simmons catheter was placed in the GRS above the level of the vascular plug for gel foam embolisation. A 12-16 mm Amplatzer Vascular Plug Type II (AGA Medical, Golden Valley, MN, USA) was deployed across



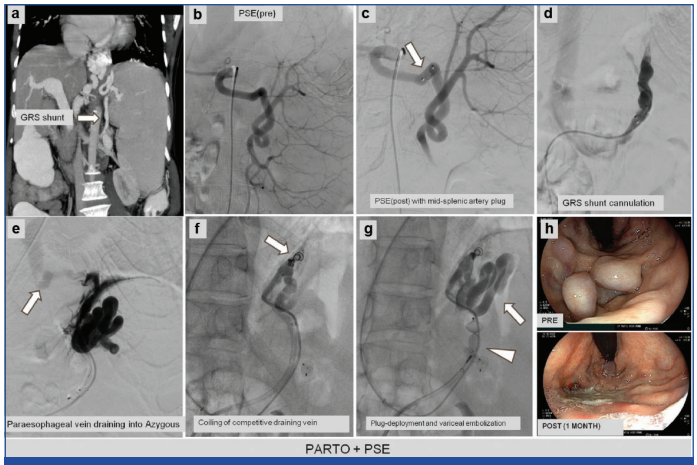
[Table/Fig-3]: (a) Post contrast Computed Tomography (CT) coronal section showing gastric varices (long arrow) with GRS shunt (short arrow); (b) Placement of 4Fr diagnostic catheter in the GRS and its position confirmed by a check veno-gram; (c) Placement of Long sheath (arrow) at the origin of GRS. 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 of the gastro-renal shunt. Jailed Microcatheter placement inside the gastric varices; (e) Gelfoam embolisation of gastric varices via the microcatheter (arrow); (f) Complete visualisation of gastric varices (arrow) with slow opacification of the posterior gastric vein (arrow heads). Procedure was concluded at this point; (g) Pre PARTO endoscopic images of large gastric varices along the fundus; (h) Post PARTO endoscopic follow-up image at 1 month shows reduction in size of gastric varices with bluish hue suggestive of thrombosis.



[Table/Fig-4]: (a) Post contrast CT coronal sections showing isolated gastric varices (arrow) with GRS (arrow head) and 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 Gelfoam and contrast; (e) AP view of gastric varices with Gelfoam and contrast (arrow); (f) Faint visualisation of left gastric vein (arrow) with stasis of contrast in the gastric varices.

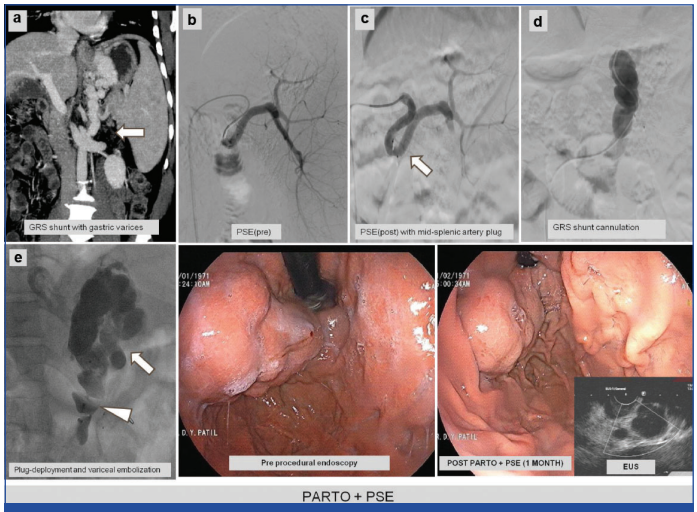
the shunt after upsizing 30–50% relative to the narrowest diameter. After confirming appropriate occlusion of the GRS on venogram via the jailed microcatheter, gel foam embolisation was performed through the same microcatheter. The endpoint of embolisation was complete opacification of gastric varices on fluoroscopy, with slow opacification and visualisation of the left gastric vein or posterior gastric vein. In situations where many collateral veins, including the pericardiophrenic, inferior diaphragmatic, and intercostal veins, are efferent feeders, coil embolisation of these feeders and subsequent Gelfoam embolisation of the gastric varices was performed.

Group B – PARTO + PSE (n=5): In addition to the above, selective catheterisation of the splenic artery was performed using a 4Fr Cobra/ Simmons-1 catheter via right femoral arterial access [Table/Fig-5,6]. Embolisation of 40-50% of the splenic parenchyma was achieved using 40-155 µm and 250-355 µm PVA particles. A 6-8



PARTO + PSE

[Table/Fig-5]: (a) Post contrast CT coronal section showing GRS shunt (arrow) with gastric varices splenomegaly (left-sided portal hypertension); (b) Pre procedure selective celiac angiogram demonstrating splenic artery and its branches; (c) Post partial splenic artery embolization demonstrating occlusion of inferior pole branches with placement of mid-splenic artery vascular plug (Amplatz Type IV); (d) Placement of 4Fr diagnostic catheter in the gastro-renal shunt and its position confirmed by a check venogram; (e) Post vascular plug deployment venogram demonstrating large paraoesophageal draining vein (arrow); (f) Coil embolisation of the paraoesophageal draining vein (arrow); (g) Gelfoam embolisation of gastric varices (arrow) with vascular plug (arrow head); (h) Pre PARTO endoscopic images of large gastric varices along the fundus; (i) Post PARTO endoscopic follow up image at 1 month shows complete disappearance gastric varices.



PARTO + PSE

[Table/Fig-6]: (a) Post contrast CT coronal section showing GRS shunt (arrow) with gastric varices splenomegaly (left-sided portal hypertension); (b) Preprocedure selective coeliac angiogram demonstrating splenic artery and its branches; (c) Post partial splenic artery embolisation demonstrating occlusion of inferior pole branches with placement of mid-splenic artery vascular plug (Amplatz Type IV); (d) Placement of 4Fr diagnostic catheter in the GRS and its position confirmed by a check venogram; (e) Vascular plug deployment (arrow head). and Gelfoam embolisation of gastric varices (arrow); (f) Pre PARTO endoscopic images of large gastric varices along the fundus; (g) Post PARTO endoscopic follow-up image at 1 month shows reduction in size of fundal varices with no colour uptake on Endoscopic Ultrasound (EUS), suggestive of complete thrombosis.

mm Amplatzer Vascular Plug Type IV (AGA Medical, Golden Valley, MN, USA) was deployed in the mid splenic artery to reduce the overall splenic flow.

Follow-up was performed at 1 month and 3 months with clinical evaluation, laboratory tests, upper GI endoscopy, and CT imaging.

Outcomes assessed-

- Technical success: Successful immediate shunt occlusion and variceal embolisation.
- Clinical success: Cessation of bleeding without recurrence during the follow-up period of 1 month.
- Complete obliteration: No residual opacification/endoscopic residual GV consistent with successful thrombosis/obliteration at 1 month follow-up.
- Partial regression: Significant decrease in size/flow with residual varix still present.
- EV progression: Increase in EV size/grade or new EV requiring prophylactic/therapeutic intervention on 1month and 3-month follow-up endoscopy.

Ascites progression was assessed separately. Complications were categorised as minor (fever, pain, groin haematoma) and major (systemic embolism, portal or renal vein thrombosis, or death) and length of hospital stay was also assessed.

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for the Social Sciences (SPSS) software version 31.0. Continuous variables were expressed as mean±SD and categorical variables as percentages. Fisher's exact test and an Unpaired Student's t-test were used; p-value <0.05 was considered statistically significant.

RESULTS

The study included 20 patients (12 males and 8 females). Group A (PARTO alone) consisted of 9 males and 6 females, while group B (PARTO + PSE) included 3 males and 2 females. Cirrhosis due to alcohol or viral hepatitis accounted for 14 patients (70%), and chronic pancreatitis for 6 patients (30%). Features of hypersplenism were present in all patients in the dual therapy group in the form of thrombocytopenia and leucopenia.

Technical success was achieved in all 20 patients (100%). Clinical success was achieved in 19/20 (95%), with no difference between groups (p-value=0.48). Complete variceal obliteration was achieved in 15/20 (75%) patients, and significant regression in 5/20 (25%). Progression of oesophageal varices was observed in 6/20 (30%) - 5 in group A and 1 in group B (p-value=0.55). Five patients underwent prophylactic Endoscopic Variceal Ligation (EVL) without rebleeding [Table/Fig-7].

Parameters	Group A – PARTO (n=15)	Group B – PARTO + PSE (n=5)	Total (n=20)	p-value
Technical success	15 (100%)	5 (100%)	20 (100%)	–
Clinical success	14 (93.3%)	5 (100%)	19 (95%)	0.48
Rebleeding	1 (6.7%)	0	1 (5%)	0.62
Gastric variceal obliteration	11 (73.3%)	4 (80%)	15 (75%)	0.72
Variceal regression (partial)	4 (26.7%)	1 (20%)	5 (25%)	–
Esophageal varices progression	5 (33.3%)	1 (20%)	6 (30%)	0.55
Prophylactic EVL	4 (26.7%)	1 (20%)	5 (25%)	–
Therapeutic EVL	2 (13.3%)	0	2 (10%)	–
Ascites progression	2 (13.3%)	0	2 (10%)	–
Minor complications	5 (33%)	5 (100%)	10 (50%)	0.04
Transient fever	1 (6.7%)	1 (20%)	2 (10%)	–
Post-embolisation pain	5 (33%)	5 (100%)	10 (50%)	–
Groin haematoma	1 (6.7%)	0 (0%)	1 (5%)	–
Major complications / mortality	0	0	0	–
Mean hospital stay (days)	4.5±1.1	9.3±0.8	–	0.12

[Table/Fig-7]: Results (PARTO vs PARTO + PSE). Statistical comparison was not performed for selected parameters due to small subgroup size

DISCUSSION

The present study demonstrates that PARTO is an effective, minimally invasive technique for managing gastric variceal bleeding, with a 100% technical success and 95% clinical success rate. Clinical outcomes have been favourable, with studies reporting high rates of complete variceal obliteration, reduced rebleeding rates, and improved overall survival in patients undergoing PARTO [2-5].

The addition of PSE showed numerically higher variceal obliteration rates (80% vs 73%), although this difference was not statistically significant in the current series. PSE acts by reducing splenic venous inflow, thereby decreasing portal pressure, which contributes to variceal decompression [6,7]. It effectively improved white blood and platelet count in all patients.

Waguri N et al., evaluated simultaneous combined BRTO and PSE in 23 patients versus BRTO alone in 13 patients with gastric fundal varices [9]. Key findings included technical success in 91-92% of cases, complete haemostasis in all ruptured variceal cases, and significantly reduced EV exacerbation in the combined group (27% at 3 years vs. 76% in BRTO monotherapy, p-value=0.0017). PSE also improved Child-Pugh scores more effectively (from 6.8 to 5.7, p-value=0.0217) and required less sclerosant volume, supporting combined therapy to mitigate post BRTO portal pressure rise. Two other studies by Waguri N et al., [10,11] with long-term follow-up of 57 BRTO patients (44 with concomitant PSE) showed sustained hepatic functional reserve gains, including increments in albumin (3.3 to 4.0 g/dL) and Albumin-bilirubin score (ALBI) (–1.94 to –2.60) with 5-year survival of 67% and no rebleeding.

The current study extends this principle by substituting balloon-based BRTO with PARTO, preserving the hemodynamic advantage while avoiding balloon-related limitations.

In the current study, all patients in group B (PARTO + PSE) had abdominal pain, mild to moderate distension and intermittent fever, which resolved with symptomatic management. There were no major complications like massive ascites/pleural effusion, portal vein/splenic vein thrombosis, splenic abscess/ bacterial peritonitis or death. Talwar A et al.,'s systematic review of PSE for hypersplenism reported adverse events in 24.5% of 1,023 patients, primarily mild (pain 21.3%, fever 15.2%, nausea 10.5%), resolving within 10 days, with major complications (abscess 2.4%, pleural effusion 1.3%) rare and manageable [8].

Tanihata H et al., reported significant portal pressure gradient increases post-BRTO of gastric varices, correlating with EV aggravation in 30% of cases due to redirected portal flow, emphasising the need for adjunctive interventions to mitigate hemodynamic shifts [12]. Similarly, Rajesh S et al., observed clinical outcomes tied to pre- and post-embolisation portal pressures in large portosystemic shunts, with progression of esophageal varices in 30% overall, aligning with known risks after shunt obliteration in cirrhosis [13]. In the current study, although the rate of oesophageal progression was lower in the combination group, the difference was not statistically significant. Prophylactic or therapeutic EVL proved effective in preventing rebleeding in these cases.

The integrated approach simultaneously addresses variceal/shunt obliteration and portal inflow modulation, which may help attenuate post-procedural portal pressure elevation and reduce rebleeding risk in selected patients, particularly those unsuitable for TIPS.

Limitation(s)

Limitations include the retrospective design, small sample size—particularly in the adjunctive PSE group—absence of direct portal pressure measurements, and short-term follow-up, which restrict conclusions regarding long-term efficacy and survival benefit.

CONCLUSION(S)

Plug-assisted retrograde transvenous obliteration (PARTO) is a safe, technically simple, and highly effective intervention for gastric variceal bleeding unresponsive to endoscopic management. Larger, prospective multicenter studies with extended follow-up are warranted to validate the long-term efficacy and survival benefits of this combined strategy.

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