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SCIENTIFIC PAPER (OTHER) TIPS

Safety and Efficacy of Portal Vein Recanalization with Creation of Intrahepatic Portosystemic Shunt (PVR-TIPS) to Treat Chronic Portal Vein Thrombosis in Non-cirrhotic Patients

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Abstract

Purpose This study assesses the efficacy and safety of Portal Vein Recanalization with Intrahepatic Portosystemic Shunt (PVR-TIPS) in non-cirrhotic patients with chronic portal vein occlusion (CPVO), cavernomatous transformation, and symptomatic portal hypertension (PH) and/or portal vein thrombotic progression.

Material and Methods Medical records of 21 non-cirrhotic patients with CPVO and portal cavernoma undergoing PVR-TIPS were analyzed. Hemodynamic (intraprocedural reduction in portosystemic pressure gradient), clinical (data on gastrointestinal bleeding, abdominal pain, ascites, and presence of esophageal varices from imaging exams) and technical success (PVR-TIPS) assessed efficacy. Safety

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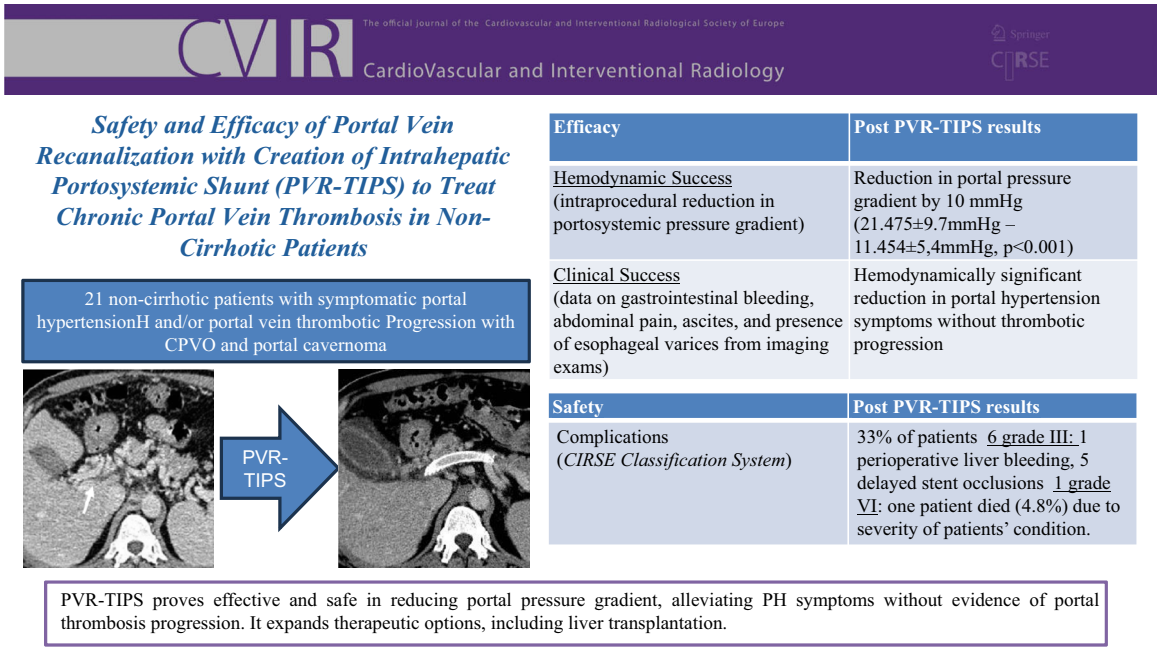
was determined through complications classified according to the *CIRSE Classification System*.

Results PVR-TIPS was successfully performed in all patients, resulting in a significant reduction in portal pressure gradient by 10 mmHg (21.475 ± 9.7 mmHg – 11.454 ± 5,4 mmHg, $p < 0.001$), alleviating portal hypertension symptoms without thrombotic progression. Clinical success included resolution or reduction of ascites ($p = 0.016$), gastroesophageal varices ($p = 0.004$), abdominal pain ($p = 0.0021$), and cessation of gastrointestinal bleeding ($p = 0.021$). Complications occurred in 33% of patients, including six grade III events (1 perioperative liver bleeding, 5 delayed stent occlusions) and one grade VI event resulting in death (4.8%). Primary patency rate was 76% (21.3 months, range:0.2–82), secondary patency 100% (4 months, range:3.8–40.8). Survival at follow-up was 90.4%, with one unrelated death. One patient underwent liver transplantation, three became eligible post-recanalization.

Conclusion PVR-TIPS proves effective and safe in reducing portal pressure gradient, thereby alleviating PH symptoms without evidence of portal thrombosis progression in non-cirrhotic patients with CPVO and portal cavernoma. It expands therapeutic options, including liver transplantation.

Graphical abstract



Keywords Chronic portal vein occlusion · Portal hypertension · Non-cirrhotic portal hypertension · Symptomatic portal hypertension · Portal vein recanalization · Portal cavenoma · Liver transplantation

Introduction

Patients with acute portal vein thrombosis (PVT) that remains unrecognized, untreated, or does not respond to initial treatment are at an increased risk of developing chronic portal vein occlusion (CPVO) [1], portal cavernoma (PC) and portal hypertension (PH) [1]. Non-cirrhotic, non-malignant PVT is a rare condition [2, 3]. Unlike PVT associated with malignancy or cirrhosis, where the outcome primarily depends on the underlying disease, non-malignant PVT in non-cirrhotic patients involves different mechanisms, with the PVT itself playing a crucial role in determining the prognosis [4, 5]. PVT can occur solely in the main portal trunk, extend to the intrahepatic portions

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[6], or involve the splenic-mesenteric venous system [7, 8]. It is classified based on the extension and occlusion percentage and categorized as recent (less than six months) or chronic (more than six months) [4]. In many patients, PVT progresses slowly and silently, often remaining asymptomatic until complications related to PH develop [2, 9]. Differentiating acute thrombosis from rethrombosis in a previously undetected PC can sometimes be challenging [2, 10]. The most significant causes of PVT in non-cirrhotic patients encompass various etiologies, including inherited or acquired prothrombotic states, local inflammatory conditions, schistosomiasis, abdominal surgery, trauma, and vascular liver disorders [11].

PH develops as a consequence of CPVO to maintain flow in the portal venous system [12, 13]. Clinical manifestations and management strategies differ depending on the stage of acute or chronic PVT [4]. CPVO may present with symptoms such as abdominal pain; gastrointestinal hemorrhage due to esophageal varices, splenomegaly, portal biliopathy, encephalopathy, ascites [14, 15].

The goals of PVT management include identifying and addressing underlying causes, preventing further thrombus extension, reducing PH, and achieving portal vein recanalization [14, 15]. In CPVO, particularly when PC is present, portal recanalization has historically been considered a relative contraindication due to technical challenges and the risk of serious complications [16].

The primary objective of Portal Vein Recanalization with Intrahepatic Portosystemic Shunt (PVR-TIPS) in CPVO with PC among non-cirrhotic patients is to reduce prehepatic PH and/or limit thrombotic progression in patients who have failed medical and/or endoscopic treatment [4, 17, 18]. This study aims to assess the effectiveness and safety of PVR-TIPS in this patient group presenting with symptomatic PH and/or portal vein thrombotic progression.

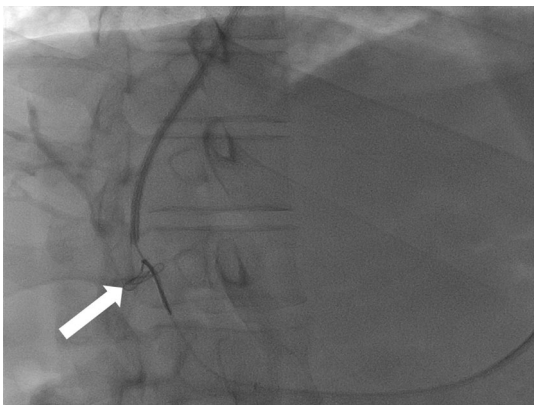

Fig. 1 Fluoroscopy demonstrating tranting communication between the hepatic and portal venous branches using the Colapinto needle (transjugular access) and snare (transsplenic access) for subsequent creation of the portosystemic tract. The arrow is indicating the snare capturing the guidewire

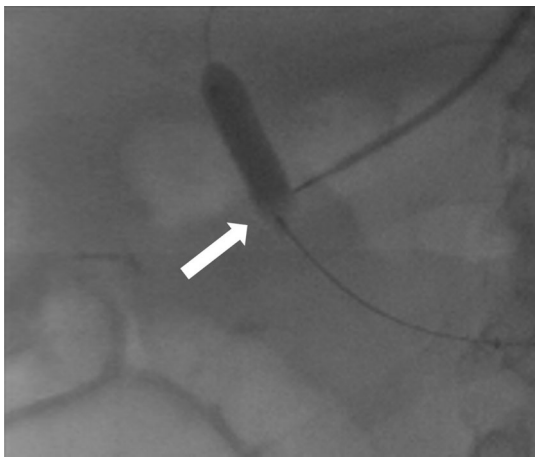

Fig. 2 Fluoroscopy demonstrating the communication between the hepatic and portal venous branches using the Colapinto needle (transjugular access) and the balloon catheter (transsplenic access) for subsequent creation of the portosystemic tract. The arrow demonstrated the balloon catheter puncture

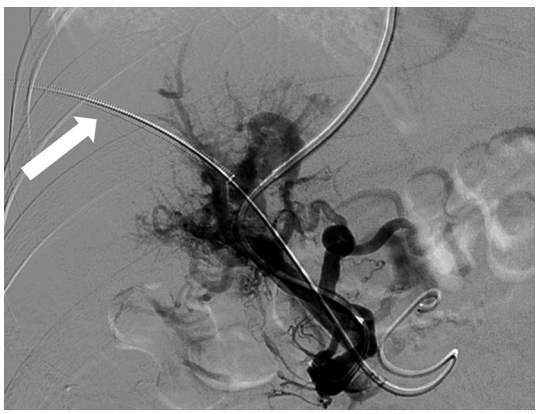

Fig. 3 Fluoroscopy demonstrating an intrahepatic portal branch (transhepatic access) and communication between the hepatic and portal venous branches (transjugular access) for subsequent creation of the portosystemic tract. The arrow is indicating the transhepatic access

Material and methods

This study was approved by the local Institutional Review Board and Ethics Committee (718–14,122,020). Informed consent was obtained from all patients in accordance with the principles of the Declaration of Helsinki and Good Clinical Practice. From May 2015 to December 2020, 94 consecutive patients underwent TIPS and/or PVR-TIPS for the treatment of symptomatic PH and/or progressive portal thrombosis at Hospital. Patients with cirrhosis, neoplastic

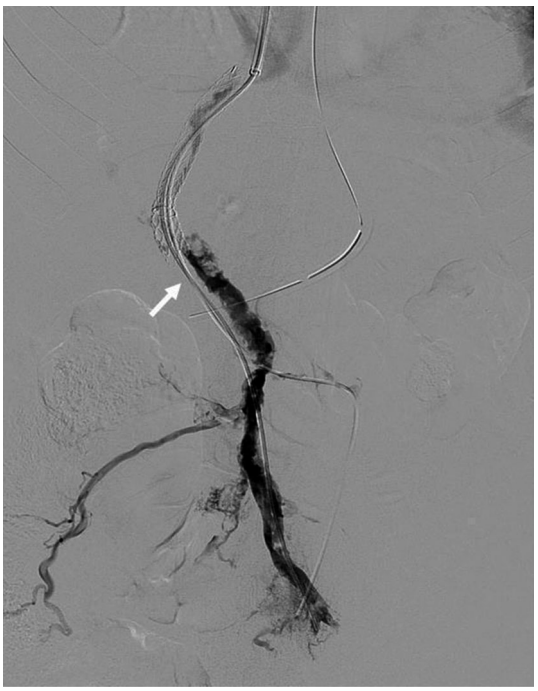

Fig. 4 Digital subtraction venography after local fibrinolytic treatment: occlusion of TIPS stent with minimal contrast passage towards the right atrium. The arrow indicates residual thrombosis in portal vein

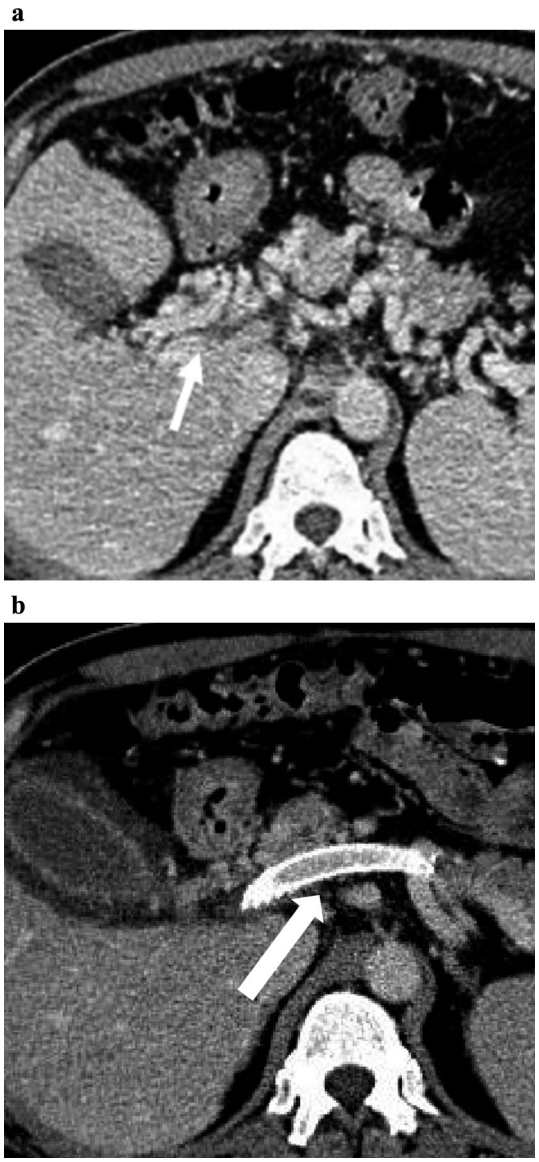

Fig. 5 **A**: Axial CT scan in venous: the arrow indicated portal cavernoma. **B**: Axial CT scan in venous phase: 6-month follow-up after PVR-TIPS. The arrow demonstrated an additional patent splenic stent

or recent portal thrombosis and hepatic tumors were excluded from the study cohort. Medical records of 21 consecutive non-cirrhotic patients diagnosed with CPVO and PC, presenting symptomatic PH and/or progressive portal thrombosis underwent PVR-TIPS were reviewed. The latest follow-up was performed in December 2023.

Hemodynamic success, defined as the reduction of portosystemic pressure gradient (PSG) during the procedure, and clinical success, based on recorded data regarding gastrointestinal bleeding, abdominal pain, ascites, and presence of esophageal varices from imaging exams, were used to determine effectiveness. Technical success was evaluated based on successful recanalization and TIPS creation. Stent patency, both primary and secondary, was assessed through routine Doppler follow-up exams at 1, 6, and 12 months. Marot and Yerdel classification assessed portal thrombosis severity on triphasic computed tomography scans. Safety was evaluated using the *CIRSE Classification System* to categorize complications [19]. Hematological screening was performed according to our Institutional Protocol and the American Society of Hematology (ASH) guidelines, evaluating both local and systemic prothrombotic factors, including inherited thrombophilias (e.g., Factor V Leiden, prothrombin gene mutation, protein C and S deficiencies, and antiphospholipid syndrome) as well as acquired conditions such as myeloproliferative neoplasms, indicated by the JAK2 mutation [20].

All patients were discussed in a multidisciplinary team comprising interventional radiologists, hepatologists, radiologists, and liver surgeons. This team collaboratively assessed and determined the appropriate indications and timing for the procedures to manage complications related to PH and address symptomatic progression of portal thrombosis.

Table 1 Demographic characteristics of non-cirrhotic patients who underwent PVR-TIPS of CPVO included in the study (PVR-TIPS: Portal Vein Recanalization with creation of Intrahepatic Portosystemic Shunt; CPVO: chronic portal vein occlusion)

Characteristics	n = 21
Number of patients (%)	21 (100)
Age in years (range)	44,7 (24–69)
Male (%)	14 (67)
BMI (kg/m2) ± SD	24 ± 3,7
Weight (kg) ± SD	71 ± 11,2
Laboratory Parameters	
AST (U/L), median (range)	34 (14–257)
ALT (U/L), median (range)	39 (11–233)
Bilirubin (mg/dL), mean (range)	0,82 (0,22–4,68)
INR, mean ± SD	1,27 ± 0,13
Creatinine (mg/dL), ± SD	0,75 ± 0,24
Platelets (10^3/μL), (range)	116 (19–800)
Albumin (g/dL), ± SD	3,64 ± 0,52
Clinical Presentation	
Upper gastrointestinal bleeding, N (%)	13 (62)
Gastroesophageal varices, N (%)	15 (71)
Ascites, N (%)	10 (48)
Hepatic hydrothorax, N (%)	2 (9,5)
Hepatic encephalopathy, N (%)	1(5)
Follow-up months (range)	33,26 (0–82)

BMI: Body Mass Index AST: Aspartate Aminotransferase ALT: Alanine Aminotransferase INR: International Normalized Ratio

Table 2 Causes of PVT in Non-Cirrhotic Patients with CPVO included in the study (PVT: Portal vein thrombosis; CPVO: chronic portal vein occlusion)

Causes of PVT	N (%)
Number of patients	21 (100)
Systemic Causes	
Patients with Hematologic Causes Assessed	19/21 (90)
Positive for Hematologic Causes	6/19 (32)
Myeloproliferative Disorders	1/19 (5)
JAK2 V617F Mutation	2/19 (10)
MTHFR C677T Mutation	2/19 (10)
Protein C Deficiency	1/19 (5)
Other systemic causes	
Exogenous hormonal supplementation	1/21 (5)
Local causes	4/21 (19)
Intra-abdominal infection	1/21 (5)
Schistosomiasis	3/21 (14)

PVT: Portal vein Thrombosis; CPVO:Chronic Portal Vein Occlusion

Technique

All procedures were performed by five expert interventional radiologists (with 10–20 years of experience in TIPS) in the interventional radiology suite (Allura Xper FD20, Philips Healthcare, Best, Netherlands), under general anesthesia. Short-term antibiotic prophylaxis with cefazoline (30 mg/kg intravenously) was administered. Platelet transfusion was considered pre-procedure if the platelet count was below 50,000 X 109 / L.

Transjugular Access

Under ultrasound (US) guidance, the right internal jugular vein was accessed (10Fr introducer) and a vascular sheath inserted into the right atrium for initial pressure measurement. A TIPS puncture needle (Ring Transjugular Intrahepatic Access Set, Cook, Bloomington, USA or GORE TIPS Set, W.L. GORE and Associates, Inc., Flagstaff, AZ, USA) was guided into an intrahepatic portal branch using hepatic US guidance and/or indirect portography. A guidewire was then navigated through the thrombosed portal vein into the splenic or mesenteric vein to ensure portal vein access. Portal venogram confirmed portal vein cannulation. After dilating the liver parenchymal track with an 8–10 mm balloon catheter, a stent (Viatorr, WL Gore & Associates, Flagstaff, AZ, USA) was deployed after portal canalization. Portal and atrial pressures were then assessed.

Transjugular and Transsplenic Access

Combined percutaneous transsplenic and transjugular access was utilized when isolated transjugular approach failed. Splenic venous branch access was achieved under US guidance, with subsequent recanalization of the occluded segment until reaching the intrahepatic portal vein. In cases of higher technical difficulty, fluoroscopic target achievement was facilitated with an endovascular snare [21] (GooseNeck snare®, Covidien, Plymouth, MN)

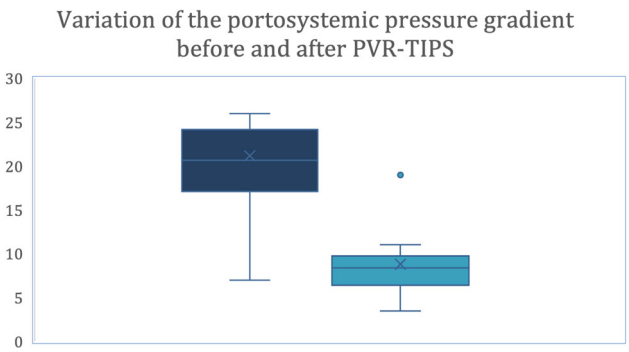

Fig. 6 Box-plot graphical representation of the reduction in portosystemic pressure gradient after PVR-TIPS

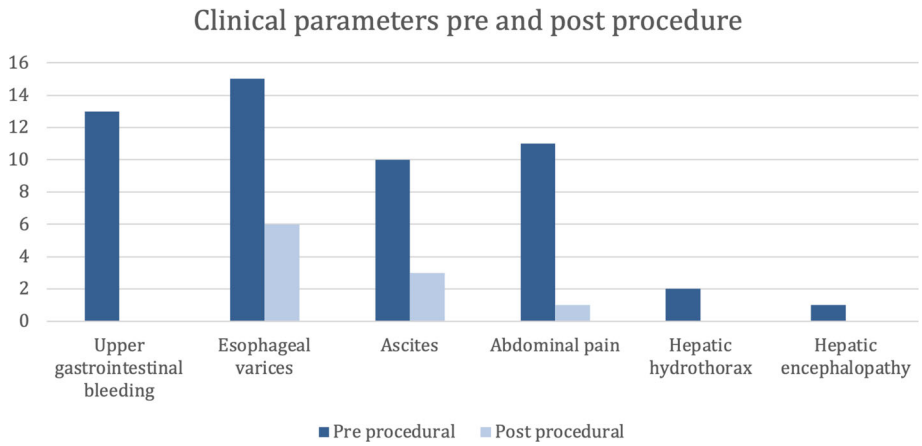

Fig. 7 Histogram graphical representation of the reduction in clinical parameters after PVR-TIPS in the 21 patients included in the study

(Fig. 1) or with a balloon catheter positioned into a thrombosed intrahepatic portal branch [22] (EV3, Ever-Cross® balloon catheter (5/8 mmx40 mm, 135 cm, Medtronic, Plymouth, MN) (Fig. 2). The transsplenic tract was embolized with glue (Glubran®) following PVR.

Transjugular and transhepatic access

Percutaneous transhepatic access was performed (Fig. 3) in cases, where transjugular access alone or combined with transsplenic access failed. With US assistance, a portal intrahepatic branch was punctured, and a 5 or 6 Fr introducer was positioned. A hydrophilic guidewire and catheter were then used to recanalize the occluded portal vein. The transhepatic tract was embolized with Spongostan after procedure (Gelfoam, Pharmacia & UpJohn Corp, New York).

Additional therapy

In cases of extensive residual thrombus causing flow limitation (Fig. 4), fibrinolysis with the EKOS® system (Boston Scientific) using Alteplase 20 mg (Actilyse®, Boehringer Ingelheim, Ingelheim Rhein, Germany) or local fibrinolysis with Urokinase (100,000 IU in a loading dose, followed by 70,000 IU/h for 6 h) was employed. Mechanical thrombus aspiration (AngioJet Peripheral Thrombectomy®, Boston Scientific) was performed. If the final result remained inadequate with residual thrombus limiting flow, metallic bare stents (SMART Control; Cordis, Cordis 8/10 mmx40/60 mm, Hialeah, FL, USA) were placed to maintain lumen patency (Fig. 5).

Anticoagulation Protocol Following PVR-TIPS

At our Center, the anticoagulation protocol after PVR-TIPS is based on the following criteria: *Full Anticoagulation:* LMWH 100 IU/kg twice daily for persistent portal

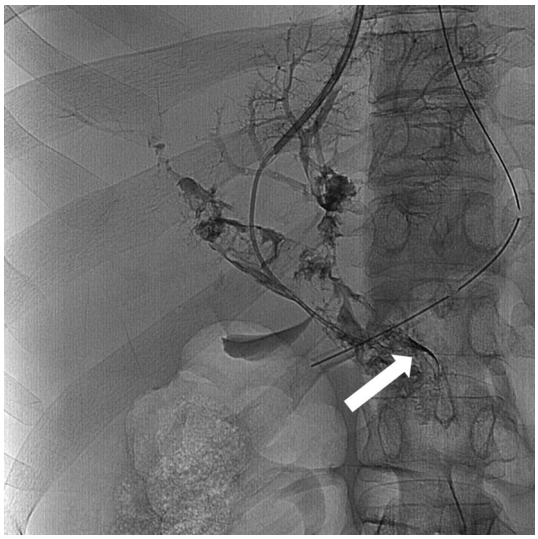

Fig. 8 Non-subtracted digital venography in a posteroanterior projection demonstrates, after access to the portal system via transjugular route. The arrow indicate extensive thrombosis of the portal trunk and intrahepatic branches (Marot III) with distal extension of the thrombosis.

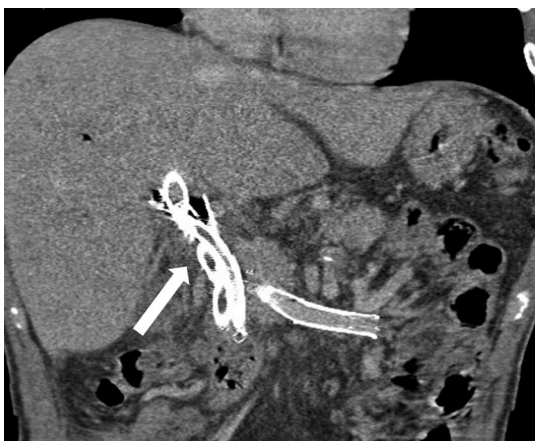

Fig. 9 Coronal CT scan in the venous phase: PVR-TIPS with an additional patent splenic stent and two biliary stents (arrow)

vein thrombosis, thrombophilia or additional stents beyond the Viatorr stent. *Prophylactic Anticoagulation:* LMWH 100 IU/kg once daily if only PVR-TIPS with angioplasty was performed and no thrombosis is present. Anticoagulation may be adjusted based on bleeding risk (e.g., platelet count < 30,000) and renal insufficiency. Lifelong anticoagulation is required for thrombophilia, stents in the portal system, or persistent thrombosis, but may be discontinued after six months or at transplantation if thrombosis has resolved.

Statistical analysis

Descriptive analysis was performed for all variables, with qualitative data presented as frequencies and percentages. Continuous variables were expressed as medians and ranges, accounting for normal and non-normal distributions. Therapeutic and clinical success rates were reported as percentages. Distribution was assessed using the Shapiro–Wilk test. Categorical and binary variables were described in absolute and relative frequency tables. Statistical comparison of pre- and posttreatment data for continuous variables utilized the paired Student's t-test, while McNemar's exact test was applied for binary variables. Statistical significance was defined as $p < 0.05$.

Table 3 Characteristics related to procedures, need for additional stents, fibrinolytic therapy, and complications of the 21 patients undergoing PVR-TIPS (PVR-TIPS: Portal Vein Recanalization with creation of Intrahepatic Portosystemic Shunt)

Intervention	N (%)
General anesthesia	21 (100)
Transjugular access	21/21 (100)
Transjugular access only	10 (48)
Transjugular and transsplenic access	8 (38)
Transjugular and transhepatic access	2 (9,5)
Transjugular, transhepatic, and transsplenic access	1 (4,5)
Complementary stents	6 (28)
Portal	2(9,5)
Mesenteric	1(5)
Splenic	3(14)
Intraprocedural local thrombolytic therapy	4 (19)
Thromboaspiration	1 (4,5)
Intra-portal fibrinolysis	3 (14)
Complications—Clavien-Dindo Classification, n (%)	7 (33)
IIIA	6 (28)
Bleeding	1 (5)
Stent occlusion	5 (24)
V Death	1 (5)

Results

Of 94 consecutive patients who underwent TIPS and/or PVR-TIPS for the treatment of symptomatic PH and/or portal vein thrombotic progression, 31 were non-cirrhotic. Among these, 87% (27/31) had portal thrombosis, and of those, 78% (21/27) exhibited CPVO with cavernomatous transformation. Clinical, surgical, and demographic data collected from electronic medical records of the 21 patients with CPVO and cavernomatous transformation who underwent PVR-TIPS are shown in Table 1, while the causes of PVT are shown in Table 2. Among these 21 patients, 67% were male, with an average age of 44.7 years (range 24–69 years).

The average time between PH symptoms onset and the PVR-TIPS procedure was 3.1 ± 1.8 years. Prior to percutaneous endovascular treatment, two patients (9.5%) underwent splenorenal shunt surgery (Warren Shunt), and one patient (4.8%) underwent splenectomy. No PVT recanalization was observed with the medical therapy alone. The median follow-up time was 26 months, with an interquartile range (IQR) of 3.8–56.9 months.

PVR-TIPS was successfully performed in all patients, resulting in a significant reduction in portal pressure gradient by 10 mmHg (21.475 ± 9.7 mmHg – 11.454 ± 5,4 mmHg, $p < 0.001$) (Fig. 6), alleviating PH symptoms without thrombotic progression. Statistically significant clinical success was observed in all treated patients. Ten patients (47.6%) had ascites before PVR-TIPS. After the procedure, ascites was still present in imaging studies (CT or US) in three patients (14.3%; $p = 0.016$), but in reduced amounts. Gastroesophageal varices disappeared in 15 (71.4%) patients ($p = 0.004$). Episodes of gastrointestinal bleeding ceased in all patients ($p = 0.021$). Among the 11 (52.4%) patients who presented with abdominal pain, only one (4.8%) continued to have this symptom ($p = 0.0021$). Hydrothorax was observed in two (9.5%) patients, and resolution was achieved in all cases. The single patient (5%) who had episodes of clinical encephalopathy had this symptom resolved with treatment (Fig. 7). No progression of portal vein thrombosis was observed after the procedure.

Hematological causes for PVT were evaluated in 19 of the 21 patients (90%), with six patients (32%) testing positive for a genetic hematological cause. One patient (4.8%) developed PVT after using estrogen-progestogen therapy. Among the local causes, three patients (14%) developed PVT following a schistosomiasis infection, and one patient (5%) after mesenteric pylephlebitis. In 10 of the 21 patients (48%), the etiological cause for PVT was not identified and was classified as idiopathic PVT.

Complications occurred in 33% (7/21) of patients, comprising six grade III complications (1 perioperative liver bleeding and five delayed stent occlusions) and one grade VI complication. The patient with hepatic bleeding had a subcapsular hematoma and underwent embolization and hematoma drainage, resulting in a favorable outcome. The primary patency rate was 76%, with an average duration of 21.3 months (range 0.2–82 months). During the US-Doppler follow-up, five patients (24%) presented hemodynamically significant stent thrombosis requiring reintervention, there was partial stent thrombosis in (4/5) and complete stent thrombosis (1/5). The average time between PVR-TIPS and stent thrombosis was 9.1 months, ranging from 3.8 to 23 months. Secondary patency was 100% in five patients at 17.4 months (range 3.8–40.8 months). The 30-days mortality rate was 4.8%. The patient, a 50-year-old woman with portal vein thrombosis (PVT) related to estrogen-progestogen therapy, developed chronic portal vein obstruction (CPVO) with progressive thrombosis extending to include distal intrahepatic thrombus, splenic-mesenteric thrombosis, and intestinal ischemia (Fig. 8). Despite attempts at percutaneous revascularization, thrombolysis, and placement of additional stents, her death was attributed to the severity of the case and unrelated to the procedure.

After PVR-TIPS, laboratory, clinical, and imaging data confirmed the presence of symptomatic portal biliopathy in 8/21 (38%) patients. Three of these patients required treatment, necessitating the placement of biliary stents due to recurrent cholestasis, jaundice, and cholangitis (Fig. 9). The overall survival rate at the end of the follow-up period was 90.4%. One patient died seven months after PVR-TIPS due to complications from an infection following biliary stent placement.

In our cohort study, Glue was used for splenic tract closure, while Gelfoam with the torpedo plugging technique was employed for portal tract closure in all cases. No complications were observed with either access tract closure method.

Liver transplantation (LT) was performed in one patient, while three others became eligible for the waiting list after portal recanalization (Table 3). The average fluoroscopy duration during the PVR-TIPS intervention was 56 ± 26–177 min, with an average Dose Area Product (DAP) of 475 ± 60–1428 Gy.cm2.

Discussion

In patients with CPVO and PC anticoagulant therapy primarily aims to prevent thrombus extension [11] rather than achieve recanalization. Endoscopic treatments provide only temporary control of variceal bleeding and do not address the underlying causes of PH [23–25]. Hematologic disorders, identified in 32% of patients, underscore the importance of screening due to the high-risk of thrombosis [26], with lifelong anticoagulation required for those diagnosed with these conditions [7]. Schistosomiasis, found in 14% of patients, was a significant local cause of portal vein thrombosis (PVT), linked to migratory population trends, despite the absence of autochthonous cases in Italy [27]. The lack of identifiable etiological factors in 48% of patients may reflect the study's small sample size. Most patients maintained normal liver function without cirrhosis, and those with hematological disease showed elevated platelet counts. Symptoms of PVT varied depending on the stage of diagnosis, the speed of thrombus formation, and its extent [28], leading to complications such as variceal bleeding, venous congestion, ischemia, and ascites [29–31]. More severe thrombosis was observed in patients with liver dysfunction. The American Association for the Study of Liver Diseases (AASLD) [4] endorses PVR-TIPS for non-cirrhotic patients with CPVO and symptomatic PH that is unresponsive to medical or endoscopic treatments. Our study found PVR-TIPS to be effective in significantly reducing the portosystemic pressure gradient (PSG) and alleviating PH symptoms, including ascites, gastroesophageal varices, digestive bleeding and reducing abdominal pain. Achieving a PSG below 12 mmHg is often the goal but can be challenging due to factors such as preexisting collateral vessels and thrombus involvement in the splenic and mesenteric veins. Recent advancements have improved the efficacy of PVR-TIPS even in complex cases [9, 16, 30]. PVR-TIPS was successfully performed in all patients, with a preference for transsplenic access over transhepatic access due to its technical ease [37]. For tract closure, we used Glubran based on our group's experience with splenic tracts, while portal tracts were closed with Gelfoam and torpedo plugging [38, 39]. Thrombus extension into the superior mesenteric vein and smaller tributaries increases the risk of intestinal ischemia and mortality [5, 40, 41]. Residual thrombus after PVR-TIPS may require additional local thrombolytic therapy to prevent rethrombosis [42, 43], as observed in 19% of our patients. The limited effectiveness of fibrinolysis in chronic thrombosis and the necessity of maintaining an adequate pressure gradient in the portal vein highlight the importance of TIPS, especially in cases of cavernous transformation. Additional bare stents were needed in 21% of patients to improve venous flow, although their placement may pose challenges for future liver transplantation. The study reported a primary patency rate of 76% at 21.3 months, with reinterventions required for stent thrombosis, emphasizing the importance of ultrasound follow-up. Thrombosis in distal intrahepatic portal segments is associated to PVR failure or early stent thrombosis due to

inadequate blood flow [6, 37]. The mortality rate was 4.8%, with the deceased patient experiencing thrombus progression and intestinal ischemia, emphasizing the need for careful risk assessment and management. Currently, no standardized guidelines exist for anticoagulation following PVR-TIPS in CPVO and cavernoma in non-cirrhotic patients. Anticoagulation is tailored to individual risk profiles, with full anticoagulation prescribed for high-risk conditions and prophylactic doses used for resolved thrombosis. Adjustments are made based on bleeding risk and renal function, with lifelong anticoagulation reserved for persistent or high-risk conditions [44, 45]. Portal biliopathy (PB) was symptomatic in 38% of patients post-PVR-TIPS, suggesting preexisting asymptomatic PB. PB can lead to cholestasis, jaundice, gallstones, and cholangitis, potentially progressing to secondary biliary cirrhosis. While radiological signs of portal cholangiopathy are common, clinical complications requiring intervention are rare [46]. However, one patient in our study succumbed to infectious complications, highlighting the potential severity of PB and the need for continuous monitoring [47–49]. Given the relatively young age of our patient cohort, potential future liver transplantation (LT) should be considered. PVR-TIPS in CPVO allows patients previously deemed ineligible for LT to become candidates [50], thus expanding treatment options for this population. Patients with CPVO often present complex vascular conditions, making intrahepatic portal venous puncture challenging. Thrombosis in the splenic-mesenteric axis, along with the need for transsplenic and/or transhepatic access and additional interventions such as catheter balloon and snare use, can extend procedure duration. Our study recorded an average fluoroscopy time of 56 min and radiation exposure of 475 Gy·cm^2, which is higher than the 39 min and 335 Gy·cm^2 reported for traditional TIPS procedures [51], yet consistent with the complexity of PVR-TIPS.

This study's limitations include its single-center, retrospective design, small sample size, and lack of a control group. Despite these constraints, it provides valuable insights into the feasibility and safety of PVR-TIPS for managing portal vein thrombosis in non-cirrhotic patients with CPVO, typically treated in specialized centers with a multidisciplinary approach. The findings emphasize the effectiveness of tailored anticoagulation, innovative techniques, and symptom relief, while also expanding treatment options. This study contributes to the existing literature and highlights the need for further studies on anticoagulation strategies, optimal timing for portal recanalization, long-term outcomes, and implications for liver transplantation.

Conclusions

PVR-TIPS demonstrates both efficacy and safety in non-cirrhotic patients with CPVO and cavernomatous transformation who present with symptomatic PH and/or portal vein thrombotic progression. Our study shows significant reductions in portal pressure gradient following the procedure, along with alleviation of PH-related symptoms and no evidence of further portal vein thrombotic progression. New therapeutic alternatives can be explored after portal recanalization, including liver transplant.

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Declarations

Conflict of interest The authors declare no conflicts of interest.

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