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CLINICAL PRACTICE UPDATES

AGA Clinical Practice Update on Management of Portal Vein Thrombosis in Patients With Cirrhosis: Expert Review

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DESCRIPTION: Portal vein thromboses (PVTs) are common in patients with cirrhosis and are associated with advanced portal hypertension and mortality. The treatment of PVTs remains a clinical challenge due to limited evidence and competing risks of PVT-associated complications vs bleeding risk of anticoagulation. Significant heterogeneity in PVT phenotype based on anatomic, host, and disease characteristics, and an emerging spectrum of therapeutic options further complicate PVT management. This Clinical Practice Update (CPU) aims to provide best practice advice for the evaluation and management of PVT in cirrhosis, including the role of direct oral anticoagulants and endovascular interventions. **METHODS:** This expert review was commissioned and approved by the American Gastroenterological Association (AGA) Institute CPU Committee and the AGA Governing Board to provide timely guidance on a topic of high clinical importance to the AGA membership, and underwent internal peer review by the CPU Committee and external peer review through standard procedures of *Gastroenterology*. These Best Practice Advice statements were drawn from a review of the published literature and from expert opinion. Because systematic reviews were not performed, these Best Practice Advice statements do not carry formal ratings regarding the quality of evidence or strength of the presented considerations.

BEST PRACTICE ADVICE STATEMENTS

BEST PRACTICE ADVICE 1: Asymptomatic patients with compensated cirrhosis do not require routine screening for PVT. **BEST PRACTICE ADVICE 2:** Patients with cirrhosis with PVTs identified on Doppler ultrasound should undergo cross-sectional imaging with computed tomography or magnetic resonance imaging to confirm the diagnosis, evaluate for malignancy, and document the degree of lumen occlusion, clot extent, and chronicity. **BEST PRACTICE ADVICE 3:** Patients with cirrhosis and PVT do not require a hypercoagulable workup in the absence of additional thromboemboli or laboratory abnormalities or family history suggestive of thrombophilia. **BEST PRACTICE ADVICE 4:** Patients with cirrhosis and PVT with evidence of intestinal ischemia require urgent anticoagulation to minimize ischemic injury. If available, these patients should be managed by a multidisciplinary team, including gastroenterology and hepatology, interventional radiology, hematology, and surgery. **BEST PRACTICE ADVICE 5:** Consider observation, with repeat imaging every 3 months until clot regression, in patients with cirrhosis without intestinal ischemia and recent (<6 months) thrombosis involving the intrahepatic portal vein branches or when there is <50% occlusion of the main portal vein, splenic vein, or mesenteric veins. **BEST PRACTICE ADVICE 6:** Anticoagulation should be considered in patients with cirrhosis without intestinal ischemia who develop recent (<6 months) PVT that is >50% occlusive or involves the main portal vein or mesenteric vessels. Patients who have increased benefit of recanalization include those with involvement of more than 1 vascular bed, those with thrombus progression, potential liver transplantation candidates, and those with inherited thrombophilia. **BEST PRACTICE ADVICE 7:** Anticoagulation is not advised for patients with cirrhosis with chronic (>6 months) PVT with complete occlusion with collateralization (cavernous transformation). **BEST PRACTICE ADVICE 8:** Patients with cirrhosis and PVT warrant endoscopic variceal screening if they are not already on nonselective beta-blocker therapy for bleeding prophylaxis. Avoid delays in the initiation of anticoagulation for PVT, as this decreases the odds of portal vein recanalization. **BEST PRACTICE ADVICE 9:** Vitamin K antagonists, low-molecular-weight heparin, and direct oral anticoagulants are all reasonable anticoagulant options for patients with cirrhosis and PVT. Decision making should be individualized and informed by patient preference and Child-Turcotte-Pugh class. Direct oral anticoagulants may be considered in patients with compensated Child-Turcotte-Pugh class A and Child-Turcotte-Pugh class B cirrhosis and offer convenience as their dosages are independent of international normalized ratio monitoring. **BEST PRACTICE ADVICE 10:** Patients with cirrhosis on anticoagulation for PVT should have cross-sectional imaging every 3 months to assess response to treatment. If clot regresses, anticoagulation should be continued until transplantation or at least clot resolution in nontransplantation patients. **BEST PRACTICE ADVICE 11:** Portal vein revascularization with transjugular intrahepatic portosystemic shunting may be considered for selected patients with cirrhosis and PVT who have additional indications for transjugular intrahepatic portosystemic shunting, such as those with refractory ascites or variceal bleeding. Portal vein revascularization with transjugular intrahepatic portosystemic shunting may also be considered for transplantation

candidates if recanalization can facilitate the technical feasibility of transplantation.

Keywords: Cirrhosis; Portal Vein Thrombosis; Portal Hypertension; Anticoagulation; Venous Thromboembolism.

Portal vein thromboses (PVTs) are common in patients with cirrhosis, with a 5-year incidence rate of 11%.[1] They are associated with advanced portal hypertension and mortality. Whether a cause[2] or a consequence[1] of liver disease progression, PVTs represent a challenging clinical conundrum. This Clinical Practice Update (CPU) aims to provide best practice advice for the evaluation and management of nonmalignant PVT in cirrhosis, including the role of direct oral anticoagulants (DOACs)[3] and endovascular interventions, as well as to explore areas of variation among guidelines.[4–7] PVT in noncirrhotic patients, malignant PVT, and hepatic venous thrombosis are outside the scope of this CPU.

Methodology

This review is framed around key clinical questions in the diagnosis and management of PVT in cirrhosis. Applicable societal guidelines and pertinent literature were reviewed and synthesized, and best practice advice statements were agreed upon by all authors. This document is not based on systematic review, so best practice advice statements were not rated for strength of evidence. This expert review was commissioned and approved by the American Gastroenterological Association (AGA) Institute CPU Committee and the AGA Governing Board to provide timely guidance on a topic of high clinical importance to the AGA membership and underwent internal peer review by the CPU Committee and external peer review through standard procedures of *Gastroenterology*.

Epidemiology, Pathophysiology, and Natural History

What Are Risk Factors for Portal Vein Thrombosis in Cirrhosis and Who Should Be Screened?

Best Practice Advice 1: Asymptomatic patients with compensated cirrhosis do not require routine screening for PVT.

Risk factors for PVT in cirrhosis include portal hypertension, slow portal flow, metabolic syndrome, and hepatocellular carcinoma.[8–10] Patients with cirrhosis have rebalanced hemostasis and a higher risk of venous thromboembolism compared with patients without cirrhosis.[6] Measurable pro-coagulant changes in hemostasis in cirrhosis, however, have not been predictive of PVT development.[10] The American Association for the Study of Liver Diseases proposes that PVT be characterized by chronicity, extent, degree of lumen obstruction, and responsiveness to therapy (Figure 1). Recent PVT is pragmatically defined as occurring within the last 6 months, based on data suggesting that PVTs that are not recanalized within 6 months are unlikely to recanalize with anticoagulation.[11] Of note, collateralization alone cannot be relied on to identify the chronicity of PVT because cavernous changes have been noted as early as 1–3 weeks after acute PVT.[12]

The natural history of PVT in cirrhosis has been described in multiple studies with serial imaging. Prospective studies have found that spontaneous recanalization in the absence of treatment occurs in 40% of patients.[6] Recurrent thrombosis after withdrawal of anticoagulation occurs in up to 38%.[13] PVT is associated with poorer clinical outcomes, including mortality, progression of portal hypertension, nonanatomic surgical anastomoses in transplantation, and worse post-transplantation survival.[14] It remains unclear whether PVT is the cause or the effect of worsening portal hypertension. A large prospective cohort study failed to identify PVT as an independent risk factor for cirrhosis progression outside of a transplantation setting.[1] A randomized controlled trial, however, which investigated the role of prophylactically dosed low-molecular-weight heparin (LMWH) in patients with cirrhosis without PVT found that anticoagulation over 96 weeks resulted in reduced incident PVT, decompensation, and mortality.[2] A more recent randomized controlled trial revealed that prophylactic rivaroxaban reduction in decompensation and mortality in patients with Child-Turcotte-Pugh (CTP) class B7 cirrhosis.[15] Meta-analyses of largely observational data have associated anticoagulation with reduction in variceal bleeding[15] and mortality benefit[16,17] (Table 1).[15–18]

There are no specific recommendations to perform routine screening imaging for PVT in asymptomatic patients with compensated cirrhosis. It is reasonable, however, to perform Doppler ultrasound to evaluate for PVT if evidence of unexplained worsening portal hypertension (eg, bleeding varices, new or progressive ascites) is seen. Transplantation candidates should be evaluated for PVT as part of the transplantation evaluation.[5] A multiphase, contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI) can evaluate for both hepatocellular carcinoma and PVT in the same setting. Although most PVT in cirrhosis is subacute and often asymptomatic, symptoms of new-onset abdominal pain should prompt evaluation for acute symptomatic PVT.

Management

What Imaging and Laboratory Assessments Are Needed in a Patient With Cirrhosis and Portal Vein Thrombosis?

Best Practice Advice 2: Patients with cirrhosis with PVTs identified on Doppler ultrasound should undergo

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Abbreviations used in this paper: **AGA, American Gastroenterological Association; CTP, Child-Turcotte-Pugh; CPU, Clinical Practice Update; CT, computed tomography; DOAC, direct oral anticoagulant; LMWH, low-molecular-weight heparin; MRI, magnetic resonance imaging; PVR-TIPS, portal vein revascularization with transjugular intrahepatic portosystemic shunting; PVT, portal vein thrombosis; VKA, vitamin K antagonist.**

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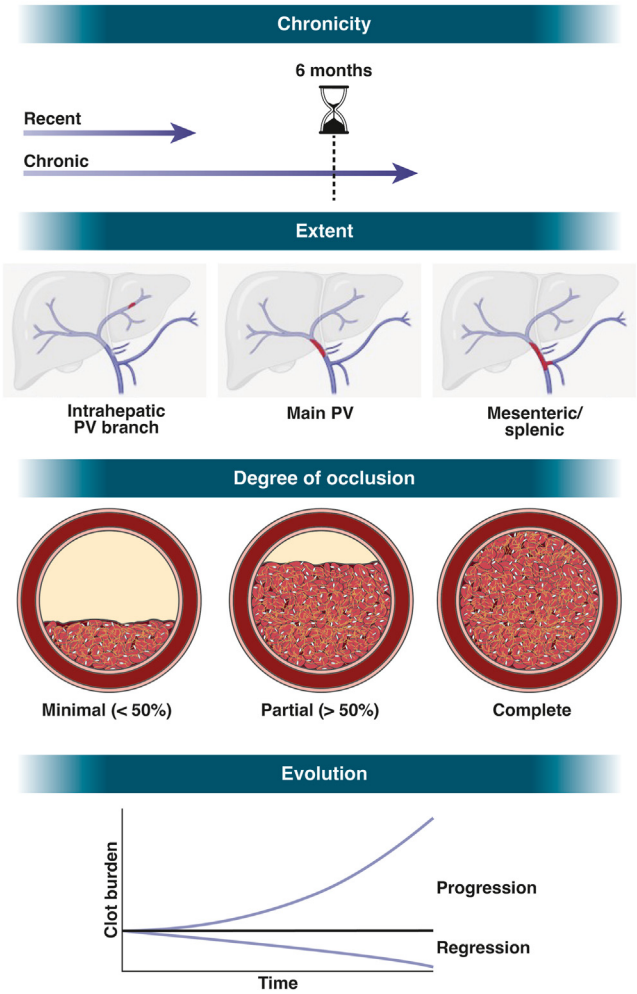

Figure 1. PVT characterization schema proposed by American Association for the Study of Liver Diseases 2020 guidelines. PV, portal vein.

cross-sectional imaging with CT or MRI to confirm the diagnosis, evaluate for malignancy, and document the degree of lumen occlusion, clot extent, and chronicity.

Best Practice Advice 3: Patients with cirrhosis and PVT do not require a hypercoagulable workup in the absence of additional thromboemboli or laboratory abnormalities or family history suggestive of thrombophilia.

The initial diagnosis of PVT in cirrhosis is established on Doppler ultrasound, which has 89%–93% sensitivity and 92%–99% specificity for PVT.[19] Cross-sectional imaging with contrast-enhanced CT or MRI should be performed to assess for concurrent hepatic malignancy, confirm diagnosis of PVT, characterize PVT by extent, degree of occlusion, chronicity, and establish a baseline for longitudinal assessment. Both CT and MRI have excellent sensitivity and specificity for PVT. If concurrent hepatic malignancy is noted on cross-sectional imaging, careful consideration for venous invasion should be made, as this will impact management. Clot appearance, proximity to tumor, and enhancement can be useful in differentiating tumor in vein from bland thrombus.[20] As portal hypertension is the main driver of PVT development in cirrhosis,[10] routine screening for thrombophilic disorders is not warranted in the absence of risk factors, such as personal history of additional thrombi, family history of thromboembolic disease or laboratory evidence of bone marrow disorder.[6]

Which Patients Need Urgent Evaluation and Anticoagulation?

Best Practice Advice 4: Patients with cirrhosis and PVT with evidence of intestinal ischemia require urgent anticoagulation to minimize ischemic injury. If available, these patients should be managed by a multidisciplinary team, including gastroenterology and hepatology, interventional radiology, hematology, and surgery.

The majority of patients with cirrhosis and PVT do not develop intestinal ischemia due to pre-existing collaterals from underlying portal hypertension.[21] This complication, however, is associated with significant morbidity and mortality up to 10%–20%,[22] so requires urgent anticoagulation. Ischemia is most likely to develop with acute and complete occlusion of the mesenteric venous system, but can present more insidiously as well.[23] Clinical features concerning for ischemia include abdominal pain out of proportion to examination; sepsis; elevated lactate; and imaging findings, such as mesenteric fat stranding or dilated bowel loops.[23] Timely anticoagulation significantly decreases the need for bowel resection and improves mortality.[11] Interventional approaches with thrombectomy and thrombolysis have also been successful and should be considered if no clinical improvement is observed with anticoagulation.[6] Care for patients with PVT and ischemia requires multidisciplinary input from gastroenterology and hepatology, interventional radiology, surgery, and hematology. If not available, patients with PVT and ischemia should be transferred to a center with these services, if possible.

Which Patients May Benefit From Nonurgent Anticoagulation?

Best Practice Advice 5: Consider observation, with repeat imaging every 3 months until clot regression, in patients with cirrhosis without intestinal ischemia and recent (<6 months) thrombosis involving the intrahepatic portal vein branches or when there is <50% occlusion of the main portal vein, splenic vein, or mesenteric veins.

Best Practice Advice 6: Anticoagulation should be considered in patients with cirrhosis without intestinal ischemia who develop recent (<6 months) PVT that is >50% occlusive or involves the main portal vein or mesenteric vessels. Patients who have increased benefit of recanalization include those with involvement of more than 1 vascular bed, those with thrombus progression, potential liver transplantation candidates, and those with inherited thrombophilia.

Best Practice Advice 7: Anticoagulation is not advised for patients with cirrhosis with chronic (>6 months) PVT with complete occlusion with collateralization (cavernous transformation).

Table 1. Summary of Findings of Selected Studies of Anticoagulation for Treatment of Portal Vein Thrombosis in Patients With Cirrhosis

Study	n	Intervention	Recanalization	Bleeding	Mortality
Traditional anticoagulants					
Loffredo et al,[15] 2017 Meta-analysis (7 OBS, 1 RCT)	353	LMWH/VKA vs no treatment	71% vs 42% ($P < .0001$)	Bleeding events 11% vs 11% Variceal bleeding: OR, 0.232 (95% CI, 0.06–0.94; $P = .04$)	NR
Guerrero et al,[16] 2023 Individual patient data Meta-analysis (5 OBS)	500	LMWH/VKA vs no treatment	aOR, 3.45 (95% CI, 2.22–5.36)	Bleeding events 19% vs 15.6% ($P = .315$) pHTN bleeding: 9.3% vs 13.9% ($P = .12$) Non-pHTN bleeding 9.7% vs 1.7% ($P < .001$)	HR, 0.59% (95% CI, 0.49–0.70)
DOACs					
Koh et al,[17] 2022 Meta-analysis (10 OBS, 1 RCT)	552	DOAC vs VKA	87% DOACs vs 44% VKA RR, 1.67 (95% CI, 1.02–2.74)	Major bleeding: RR, 0.29 (95% CI, 0.08–1.01) Variceal bleeding: RR, 1.29 (95% CI, 0.64–2.59)	RR, 0.31 (95% CI, 0.01–9.58)
Ai et al,[18] 2020 (OBS)	80	Rivaroxaban or dabigatran vs no treatment	28% vs 3% ($P = .003$)	Bleeding events: 8% vs 3% ($P > .05$)	NR

aOR, adjusted odds ratio; HR, hazard ratio; NR, not reported; OBS, observational; pHTN, portal hypertension; RCT, randomized controlled trial; RR, relative risk.

Even in the absence of intestinal ischemia, some patients with cirrhosis and PVT benefit from timely anticoagulation. First, recanalization can improve portal flow and reduce portal hypertension, potentially reducing the risk of future disease progression and decompensation. Second, in patients awaiting transplantation, recanalization preserves anatomic anastomoses and reduces surgical technical challenges. In a large meta-analysis, anticoagulation increased recanalization rate with an odds ratio of 4.8 (95% CI, 2.7–8.7; $P < .0001$).[15] However, as many patients recanalize without treatment, and not all patients respond to anticoagulation, it is critical to assess each patient's risk–benefit profile.

Given the paucity of randomized, prospective trials and lack of standardized PVT classification and outcomes, decision making for anticoagulation should be individualized on a case-by-case basis. A helpful framework to identify potential benefit from anticoagulation is to divide patients into the following 3 groups based on PVT characterization: 1) recent but minimally obstructive (<50%) thrombi, 2) recent and partial (>50%) or completely obstructive and/or extensive thrombi, and 3) chronic, well-established thrombi with extensive collateralization (Figure 2). Comorbid hypercoagulable state, evolution of the thrombus over time (ie, regression or progression), presence of symptoms, and potential transplantation candidacy should also be considered. Finally, risks of anticoagulation should be assessed, including history of bleeding, fall risk, frailty, and thrombocytopenia.

In patients with recent PVTs (<6 months) that are limited in extent and minimally obstructive (<50%), it is reasonable to monitor with serial cross-sectional imaging, given high reported rates of spontaneous recanalization.[1] Individuals with symptomatic PVT, clinically worsening portal hypertension, awaiting liver transplantation, or those who have progression of the PVT on serial imaging would have higher potential benefits from anticoagulation.

In patients with recent (<6 months) PVT with partial or complete (50%–100%) obstruction and/or involvement of multiple vascular beds, the potential benefits of

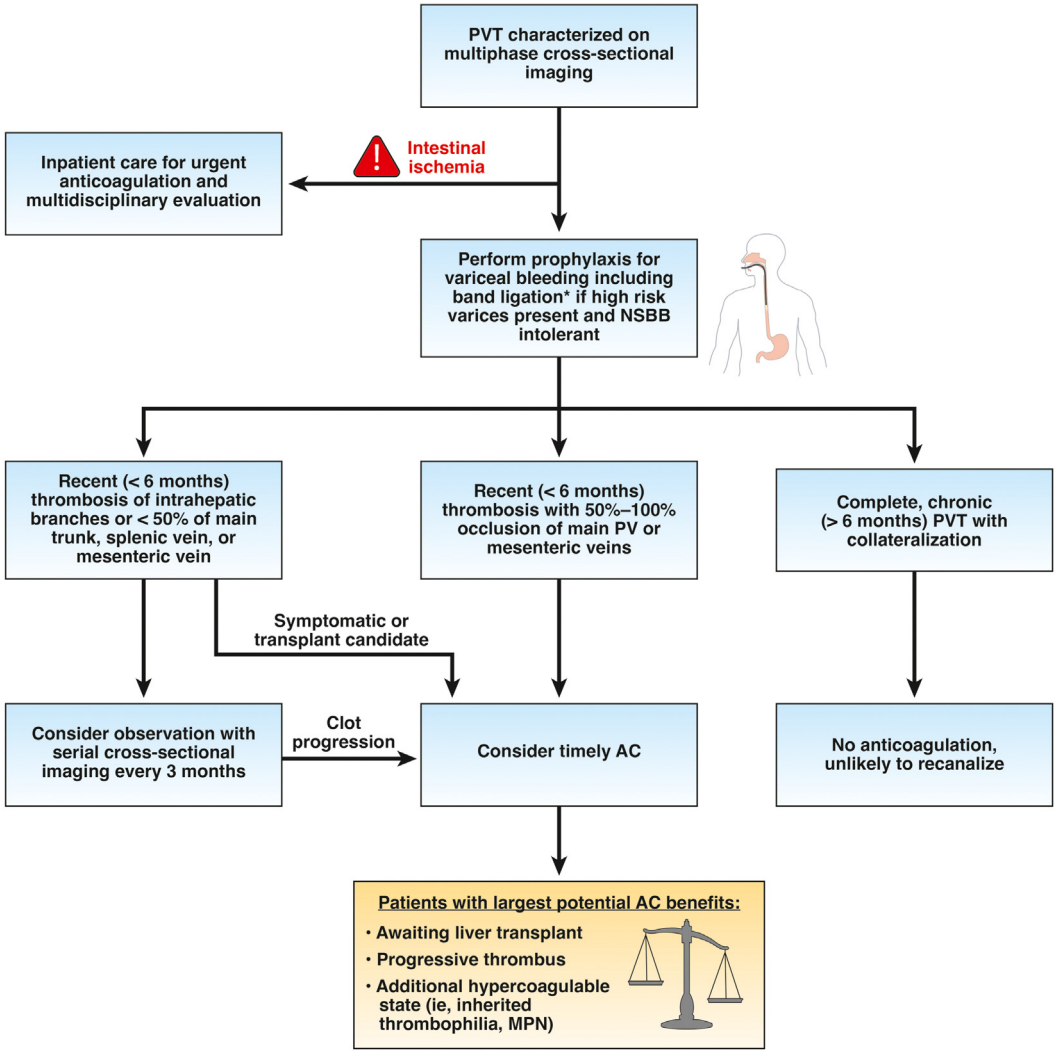

Figure 2. Algorithm for management of PVT in cirrhosis. *Limited data support safety of endoscopic ligation on AC. AC, anticoagulation; MPN, myeloproliferative neoplasm; NSBB, nonselective beta blockers. Created with BioRender.com.

recanalization are high. Per Pouiseuille's law, those with 50% lumen obstruction have a 94% reduction in flow, so the physiologic impact of clots is significant.[21] Furthermore, the odds of recanalization are higher, given recent onset. Anticoagulation should be considered in this group.

In patients with chronic (≥6 months) PVT with complete obstruction of the main trunk and mature cavernoma formation, the odds of recanalization are low.[11] There are minimal data available that address the impact of anticoagulation in these extensive, mature PVT. One prospective observational study of 102 patients with acute PVT, albeit in patients without cirrhosis, does inform the likelihood of later recanalization. Ninety-five patients were started on early (median within 13 days of diagnosis) anticoagulation. Thirty-eight percent of patients with PVT recanalized. No patient that failed to recanalize in the initial 6 months of therapy went on to recanalize even with continued anticoagulation.[11] Thus, anticoagulation should not be used routinely in this group.[6] Those with chronic PVT with partial or minimal occlusion and no cavernomas likely have better odds of recanalization than those with complete occlusion and cavernomas, however, overall chance of recanalization remains generally low after 6 months.[11] Decision making should be individualized in this cohort and those with increased potential benefit (eg, awaiting liver transplantation with a need to preserve remaining patent vasculature) may be considered for anticoagulation trial, despite low odds of recanalization.

Should Anticoagulation Be Delayed Until Endoscopic Variceal Screening Is Performed?

Best Practice Advice 8: Patients with cirrhosis and PVT warrant endoscopic variceal screening if they are not already on nonselective beta-blocker therapy for bleeding prophylaxis. Avoid delays in the initiation of anticoagulation for PVT, as this decreases the odds of portal vein recanalization.

Patients with cirrhosis and PVT require variceal screening, given the established association with PVT, variceal bleeding, and portal hypertension progression.[5] Primary and secondary prophylaxes mirror general recommendations for varices in patients with cirrhosis. Although endoscopic risk assessment and prophylaxis are important, this must be balanced with delays in anticoagulation, which reduce recanalization rates. In one study, initiation of anticoagulation within 6 months of PVT diagnosis correlated with recanalization (relative risk, 3.3; 95% CI, 1.2–9.4; $P = .004$).[24] Additional studies have shown the benefit of even earlier anticoagulation, as initiation within 2 weeks of diagnosis was associated with improved recanalization rates vs those beyond 2 weeks.[25] Furthermore, 2 large meta-analyses, including more than 800 patients, suggested that anticoagulation does not increase the risk of portal hypertensive bleeding in patients with cirrhosis and PVT[15,16] and small retrospective studies supported safety of endoscopy for variceal ligation on anticoagulation.[26,27] One retrospective study of largely decompensated patients showed rate of post-ligation bleeding in patients on anticoagulation was 9%, comparable with reported rates in patients not on anticoagulation undergoing variceal ligation.[28] In fact, anticoagulation in patients with cirrhosis with PVT may reduce portal hypertensive bleeding by lowering portal pressure via recanalization.[15] Current societal guidelines are not uniform in their recommendations on timing of anticoagulation initiation; whereas the European Association for the Study of the Liver recommended deferral until variceal prophylaxis is in place,[4] the American Association for the Study of Liver Diseases noted the absence of strong evidence and recommended initiation as soon as possible,[6] and Baveno VII portal hypertension consensus guidance recommends variceal ligation in patients undergoing anticoagulation with vitamin K antagonists (VKAs).[5]

What Anticoagulant Agents Are Available for Treatment of Portal Vein Thrombosis in Cirrhosis?

Best Practice Advice 9: VKAs, LMWH, and DOACs are all reasonable anticoagulant options for patients with cirrhosis and PVT. Decision making should be individualized and informed by patient preference and CTP class. DOACs may be considered in patients with compensated CTP class A and CTP class B cirrhosis and offer convenience, as their dosages are independent of international normalized ratio monitoring.

Trials examining the use of VKAs, LMWH,[29–31] and DOACs in patients with cirrhosis and PVT have varied in design, treatment end points, and duration (Table 1). High recanalization rates have been reported in studies of LMWH and/or VKA,[15,16] including a meta-analysis of 8 observational studies[15] comprising 353 patients, which confirmed higher PVT recanalization rates in anticoagulation (LMWH or warfarin) vs no treatment group (71% vs 42%; $P <$ .0001), as well as lower incidence of variceal bleeding. Importantly, on subgroup analysis, LMWH had a larger effect on complete recanalization than warfarin compared with no treatment (odds ratio, 8.386; 95% CI, 3.287–21.3 vs odds ratio, 2.2; 95% CI, 0.742–6.720); both LMWH and warfarin were effective in reducing progression of PVT. Another meta-analysis[16] of 500 patients confirmed that anticoagulation was associated with higher recanalization (adjusted odds ratio, 3.45; 95% CI, 2.22–5.36) and lower all-cause mortality (hazard ratio, 0.59; 95% CI, 0.49–0.70), independent of thrombosis severity and recanalization. Non–portal hypertension–related bleeding was greater in the anticoagulation group in this analysis (9.7% vs 1.7%; $P <$ .001).

Despite limited data, clinicians are increasingly applying DOACs to the treatment of PVT in cirrhosis.[3] Early data suggest promising efficacy and safety, including a prospective cohort study,[18] which reported higher recanalization rates and no difference in bleeding rates in the DOAC (rivaroxaban in 26 CTP class A patients, dabigatran in 14 CTP class B/C patients) vs control group (no anticoagulation in 40 patients). Studies comparing different DOAC agents have not reported significant differences in recanalization, overall bleeding, or mortality rates,[32] although studies

comparing DOACs with VKAs, have revealed a higher recanalization rate with DOACs. A meta-analysis[17] of 11 studies of patients with cirrhosis confirmed higher PVT recanalization in the DOAC group (87% vs 44%; relative risk, 1.67, 95% CI, 1.02–2.74); and no difference in variceal bleeding or death was noted between groups.

In summary, more data are available for VKAs and LMWH in the treatment of PVT compared with DOACs; however, the serial blood monitoring required of VKAs is cumbersome and unreliable in cirrhosis. LMWH is inconvenient, as it requires parenteral injection, but its shorter duration of action can be an advantage in patients awaiting transplantation or requiring frequent procedures (such as serial large therapeutic thoracentesis or paracentesis). Although DOACs have a smaller body of evidence, they are convenient. They can be used safely in patients with CTP class A and with caution in CTP class B cirrhosis or creatinine clearance <30 mL/min; but are not advised in CTP class C (Supplementary Table 1). DOACs (mainly rivaroxaban) are associated with a small risk of hepatotoxicity[33] and can be counteracted by reversal agents, albeit with thrombosis risk.[34,35]

VKAs, LMHW, or DOACs can be considered in CTP class A and class B cirrhosis and LMWH in CTP class C cirrhosis and in those with high Model for End-Stage Liver Disease score nearing transplantation. DOACs have become preferred by many clinicians due to ease of use, especially apixaban.[3] Randomized controlled trials are needed to better define the role of DOACs in patients with cirrhosis and PVT.

What Is the Ideal Duration of Anticoagulation for Portal Vein Thrombosis in Cirrhosis?

Best Practice Advice 10: Patients with cirrhosis on anticoagulation for PVT should have cross-sectional imaging every 3 months to assess response to treatment. If clot regresses, anticoagulation should be continued until transplantation or at least clot resolution in nontransplantation patients.

Treated patients should be evaluated every 3 months with CT or MRI. Patients experiencing complete recanalization or partial regression can continue anticoagulation with reimaging every 3 months. Adherent patients who experience no response or PVT progression may be considered for salvage intravascular procedures or treatment discontinuation.[4] Anticoagulation can be discontinued for futility in nonresponders after 6 months, as recanalization is unlikely.[11] Recurrent PVT after revascularization or treatment discontinuation occurs within 2–5 months in up to 38% of patients.[24,25] As such, anticoagulation should be continued after resolution of PVT in patients listed for liver transplantation and considered on an individual basis in other patients.[5] Although a platelet count $<50 \times 10^9$/L has been associated with a bleeding risk in patients on anticoagulation, cautious use may be considered on an individualized basis. Although supported by limited data, thromboelastography may represent a promising tool to assess bleeding risk,[18] and may help guide decision making regarding risks and benefits of anticoagulation use.

What Is the Role of Vascular Intervention for Portal Vein Thrombosis in Cirrhosis?

Best Practice Advice 11: Portal vein revascularization with transjugular intrahepatic portosystemic shunting (PVR-TIPS) may be considered for selected patients with cirrhosis and PVT who have additional indications for TIPS, such as those with refractory ascites or variceal bleeding. PVR-TIPS may also be considered for transplantation candidates if recanalization can facilitate the technical feasibility of transplantation.

PVR-TIPS should be considered for patients with cirrhosis and PVT who have additional indications for TIPS, that is, refractory ascites, hydrothorax, or variceal bleeding.[6] Revascularization may have particular benefits in patients who would otherwise not be transplantation candidates due to limitations in vascular anatomy. Studies assessing the benefits of PVR-TIPS in patients with cirrhosis and PVT awaiting transplantation[36,37] confirmed a high PV revascularization rate and improved transplantation outcomes, including successful revascularization in 98% of patients with complete or near-complete (>95%) occlusion,[36] and achieving >90% end-to-end portal vein anastomoses at transplantation among patients who underwent PVR-TIPS for chronic obliterative PVT.[38] It should be noted that the majority of patients in this cohort had a Model for End-Stage Liver Disease score <14 and all 3 series were from a single center with significant technical expertise, limiting the generalizability of these data. Transplantation candidates who fail anticoagulation and have complete thrombosis of the PV with or without mesenteric vein thrombosis may benefit from PVR-TIPS. Insufficient evidence is presently available to confirm the role of anticoagulation post PVR-TIPS.

PVTs are common in patients with cirrhosis and are associated with progression of portal hypertension and mortality. The treatment of PVT remains a clinical challenge due to the competing risks of PVT-associated complications vs bleeding risk of anticoagulation, significant heterogeneity in PVT phenotype based on anatomic, host, and disease characteristics, and an emerging spectrum of therapeutic options. The decision to pursue PVT treatment should be reached on an individual basis with careful benefit–risk assessment and consideration of local expertise and patient preference. Patients with acute, extensive thrombi have the largest potential benefit from intervention, particularly if they are candidates for liver transplantation. Significant gaps remain in advancing our field toward a more evidence-based approach to the management of PVT in patients with cirrhosis and will be guided by improved assessment tools for coagulation function (eg, thromboelastography), harmonization of guidelines on PVT classification and clinical outcomes, and randomized controlled trials for comparison of therapeutic strategies across PVT phenotypes and CTP class. These best practice advice

statements provide gastroenterology clinicians with a pragmatic clinical approach for contemporary management based on the best available evidence.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Gastroenterology* at www.gastrojournal.org, and at https://doi.org/10.1053/j.gastro.2024.10.038.

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Jessica P. E. Davis: drafted manuscript and figures/tables, revised manuscript and figures/tables. Joseph K. Lim: revised manuscript and figures/tables. Fadi F. Francis: drafted manuscript, revised manuscript and figures/tables. Joseph Ahn: revised manuscript and figures/tables.

Conflicts of interest
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Supplementary Table 1. Properties of Anticoagulants Available for Treatment of Portal Vein Thrombosis in Cirrhosis

Agent	Mechanism	Hepatic impairment posing per CPT class	Renal impairment dosing	Reversal agent	Advantages	Disadvantages
Traditional anticoagulants						
VKA	VKA	A/B/C: no dose adjustments	No dose adjustments	Phytonadione 4-factor PCC	Oral Large body of evidence	Requires INR monitoring
LMWH	Activate antithrombin	A/B/C: no dose adjustments	Yes Avoid in HD	Protamine sulfate	Large body of evidence Short half-life	Subcutaneous Weight-based dosing
DOACs						
Apixaban	Factor Xa inhibitor	A: no dose adjustment B: use with caution, no dose adjustment C: not advised	Yes Not labeled for CrCl <30 mL/min	Andexanet alfa 4-factor PCC	Oral Has data for use in CPT class B	
Rivaroxaban	Factor Xa inhibitor	A: no dose adjustment B/C: not advised	Yes Minimal data for CrCl <15 mL/min	Andexanet alfa 4-factor PCC	Oral	
Dabigatran	Thrombin inhibitor	A: no dose adjustment B: use with caution, no dose adjustment C: not advised	Yes Not labeled for CrCl <30 mL/min	Idarucizumab	Oral	Not advised if LFTs >2× ULN
Edoxaban	Factor Xa inhibitor	A: no dose adjustment B/C: not advised	Yes Not advised for CrCl <15 mL/min	4-factor PCC Andexanet alfa (off-label)	Oral	
Fondaparinux	Factor Xa inhibitor	A/B: no dose adjustment C: not advised	No adjustment for CrCl >30 mL/min, use CI in CrCl <30 mL/min or HD	None	Can be used in HIIT	Subcutaneous

CrCl, creatinine clearance; HD, hemodialysis; HIIT, heparin-induced thrombocytopenia; INR, international normalized ratio; PCC, prothrombin complex concentrate; ULN, upper limit of normal.