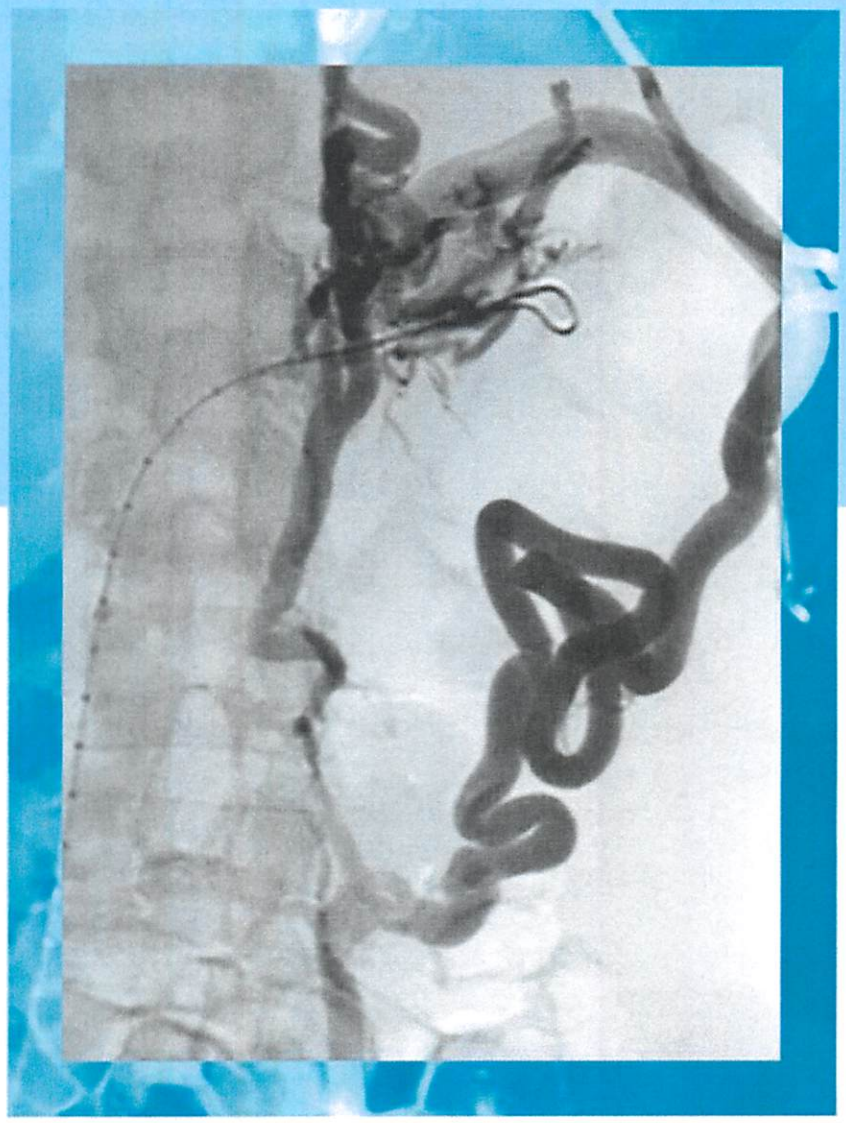
Venous Interventional Radiology

Laura K. Findeiss



Thieme

Contents

	Preface	ix
	Acknowledgments	xi
	Contributors	xiii
1	**Venous Anatomy and Physiology and Epidemiology of Venous Disorders** *Kathleen Hamrick and Laura K. Findeiss*	1
2	**Venous Thromboembolism** *Matthew T. Rondina and Hanadi Farrukh*	15
3	**Cerebral Venous Thrombosis** *Nitish Dhingra and Kieran Murphy*	30
4	**Acute Deep Venous Thrombosis: Sporadic and Compressive** *Kyle Cooper, Minhaj S. Khaja, and Bill S. Majdalany*	35
5	**Pulmonary Embolism** *Ronald S. Winokur and Akhilesh K. Sista*	52
6	**Inferior Vena Cava Filters** *Robert L. King and Matthew S. Johnson*	59
7	**Chronic Venous Occlusive Disease** *Deepak Sudheendra*	67
8	**Peripheral Venous Insufficiency** *Mary Costantino*	74
9	**Venous Access** *Todd Hoffman, Laura K. Findeiss, and Gordon McLennan*	84
10	**Pelvic and Gonadal Venous Reflux** *Douglas A. Murrey, Bill S. Majdalany, and Minhaj S. Khaja*	99
11	**Portal and Mesenteric Venous Disorders** *Maria del Pilar Bayona-Milano and Hector Ferral*	114
12	**Venous Anomalies and Syndromes: Classifications, Evaluation, and Treatment** *Christopher R. Bailey, Scott R. Shuldiner, and Clifford R. Weiss*	141
	Index	152

7 Chronic Venous Occlusive Disease

Deepak Sudheendra

Summary
Chronic venous occlusive disease (CVOD) is commonly treated conservatively by the medical community at large. Most patients with symptomatic CVOD are managed with long-term extremity compression garments, and often with chronic anticoagulation. Many patients suffer from lifestyle-limiting symptoms, and sequelae can include signs and symptoms of chronic venous stasis, with soft tissue changes or ulceration. This chapter familiarizes the reader with standards for evaluation and management of patients with symptomatic CVOD, including review of techniques for recanalization of occluded venous segments with tips for postprocedural longitudinal management of these patients.

Keywords: deep vein thrombosis, stents, postthrombotic syndrome, angioplasty, caval thrombosis, venous thrombosis, IVC filter, May–Thurner syndrome

7.1 Introduction

Chronic venous occlusive disease (CVOD) resulting from deep vein thrombosis (DVT) is characterized by a constellation of symptoms collectively known as postthrombotic syndrome (PTS). The characteristic chronic leg swelling, pain, skin changes, varicose veins, and venous stasis ulcers affect nearly 50% of patients with proximal iliofemoral DVT within the first 1 to 2 years of presentation.[1] CVOD results in significant morbidity as well as personal, emotional, and economic costs to the individual and society.[2] The vast majority of patients with CVOD never undergo treatment and most are never referred to a vascular specialist for management.

Most commonly, CVOD can broadly be categorized into those cases resulting from inferior vena cava (IVC) filter complication and those due to proximal DVT. The technical approach and medical management of these conditions are discussed herein.

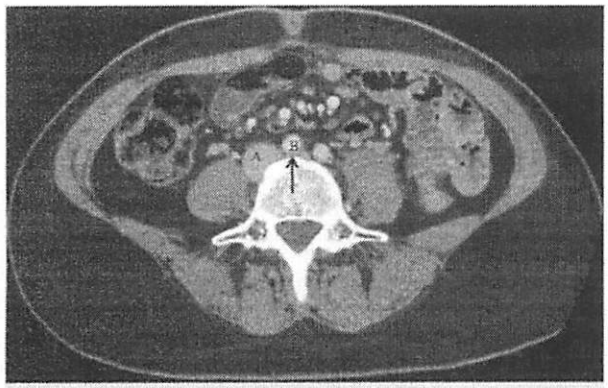


Fig. 7.1 CT venogram showing bifurcation of the IVC into the right common iliac vein (a) and the left common iliac vein (*arrow*) that is compressed by the overlying right common iliac artery (b).

7.2 Case Vignette 1

7.2.1 Patient Presentation

A 35-year-old woman developed acute left iliofemoral DVT 2 days postpartum, presenting with chronic left leg swelling, muscle fatigue, cramping, and intermittent left buttock pain. Warfarin therapy was prescribed for 6 months, followed by treatment with rivaroxaban (Janssen Pharmaceuticals, Rariton, NJ) for 3 months. Nine months following her initial presentation, due to ongoing symptoms of CVOD, a CT venogram was obtained and demonstrated significant left common iliac vein compression and thrombotic occlusion of the left external iliac vein. At that time, she underwent an unsuccessful attempt at recanalization of her left external iliac vein. It was recommended that she continue anticoagulation indefinitely and wear thigh-high compression stockings. Two years later, she presented for reevaluation. At that time, she reported significant swelling in the left lower extremity with failure to use compression. She was an avid runner and unable to run long distances or do prolonged physical activity due to pain and swelling.

7.2.2 Physical Exam

On physical examination, the patient was a slender woman with mild asymmetric enlargement of the left lower extremity, relative to the right. She had no obvious skin manifestations, varicosities, or ulcers.

7.2.3 Noninvasive Testing

Review of the initial preoperative CT venogram from 2 years prior showed significant compression of the left common iliac vein by the overlying right common iliac artery, suggestive of May–Thurner syndrome (▶ Fig. 7.1a; ▶ Fig. 7.1b). A duplex ultrasound (US) performed contemporaneous to the consult revealed occlusion of the left external iliac vein with patent common femoral, femoral, and popliteal veins (▶ Fig. 7.2).

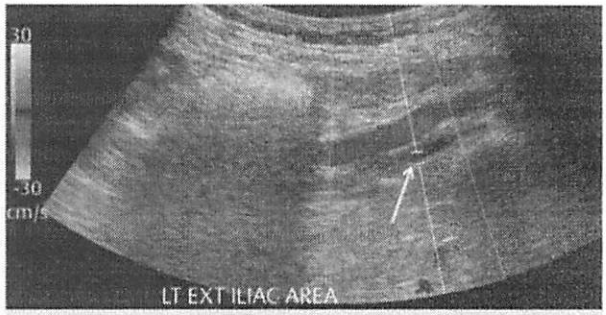


Fig. 7.2 Duplex US showing no venous flow in the left external iliac vein (*arrow*).

7.2.4 Invasive Testing

The catheter venogram from the prior recanalization procedure showed a left common femoral vein access with occluded left external iliac vein and mature pelvic collaterals draining to the right external iliac vein.

7.2.5 Specifics of Consent

The risks and benefits of reattempting recanalization of the patient's chronically occluded left external iliac vein were discussed in detail. Specifically, the expectation of getting through a chronic occlusion that had been previously attempted was put into perspective. Potential complications such as vascular injury and bleeding were discussed. Complications such as iliac vein thrombosis or stent occlusion that could necessitate additional procedures in the future were also described. Self-limited side effects, including access site pain and back pain, that may accompany iliac vein stenting were discussed. Although the likelihood of using thrombolytics was low due to the chronicity of the occlusion, the risks of bleeding from thrombolytics was discussed if acute or subacute thrombus was found during the procedure requiring pharmacomechanical thrombectomy. Finally, a tentative plan for postprocedural anticoagulation was outlined, including the type and length of anticoagulation.

Details of Procedure

A preprocedural plan was formulated to ensure the best possible outcome. The plan was to gain access to the left femoral vein in the midthigh or the left great saphenous vein with an 8F, 10-cm sheath and perform a venogram. Attempts would be made to cross the occluded left external iliac vein with a hydrophilic guidewire, 5F Bern catheter (Boston Scientific, Marlborough, MA), followed by angioplasty and Wallstent placement (Boston Scientific, Marlborough, MA). Intravascular US (IVUS) (Volcano Corporation, San Diego, CA) would also be used for sizing and stent positioning and to determine the extent of compression of the left common iliac vein.

The patient was placed in the supine position, general anesthesia induced, a bladder catheter placed, and US evaluation performed to determine the optimum access site. The right neck and left groin down to the knee were prepped. Initially access was gained in the left greater saphenous vein should stenting be required into the femoral vein. Venography was performed which showed occlusion of the left common iliac vein with patent left internal iliac draining to the iliac confluence and cross-pelvic collaterals draining to the right external iliac vein (▶ Fig. 7.3a). Second access was obtained in the right internal jugular vein and a long 6F braided sheath was placed to the level of the left common iliac occlusion (▶ Fig. 7.3b). Several

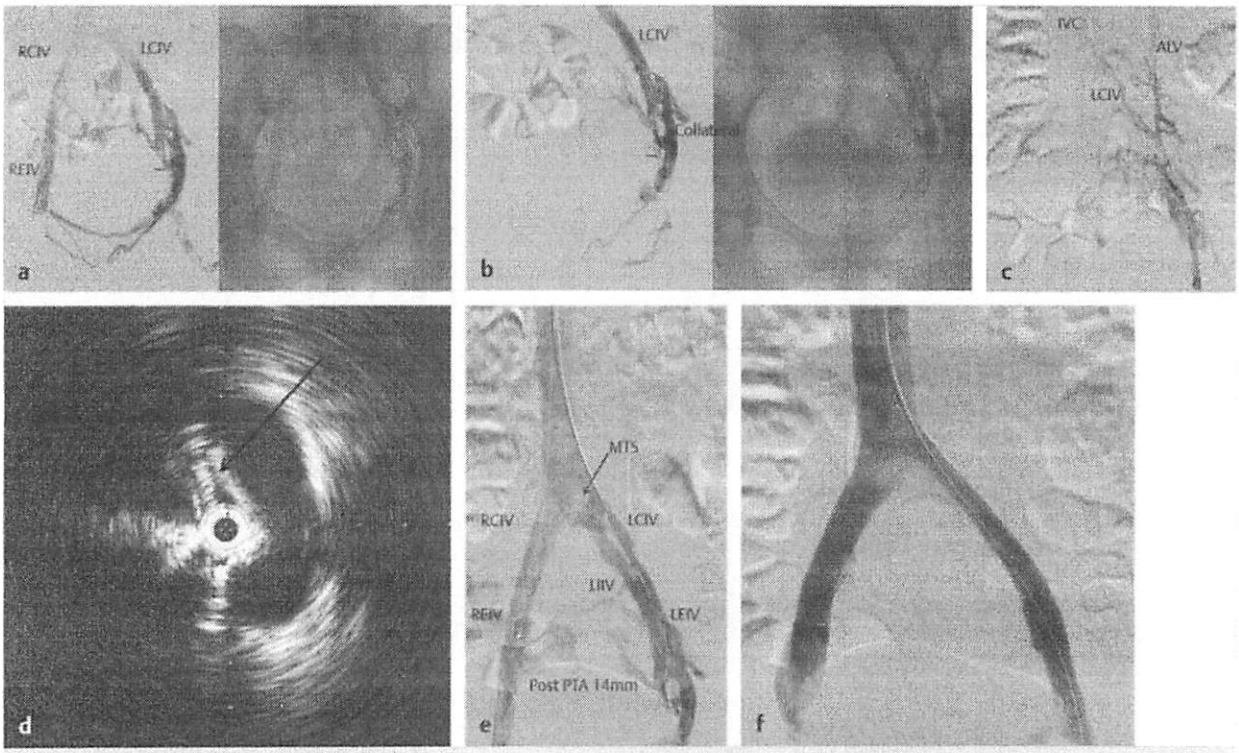


Fig. 7.3 (a) Venogram showing complete occlusion of the *supposed* left external iliac vein with prominent collateral draining to right external iliac vein (REIV). The right common iliac vein (RCIV) is patent. The *supposed* left common iliac vein is patent. (b) Sheath is shown in what appears to be the left common iliac vein (LCIV) and catheter tip is in large pelvic collateral vein. (c) Venogram illustrating ascending lumbar vein (ALV) joining a severely stenotic left common iliac vein (LCIV). A trace amount of contrast is seen draining into the IVC. (d) Compression of the left common iliac vein (*arrow*) as seen by IVUS. (e) Venogram after angioplasty of the stenotic LCIV shows two venous channels. The vein that was thought to be the patent LCIV is actually the left internal iliac vein (LIIV) that has a high bifurcation directly from the IVC. The area where no contrast is seen is characteristic of May–Thurner syndrome (MTS). (f) Completion venogram after Wallstent placement that extends slightly into the IVC to minimize rethrombosis as the weakest parts of the stent are the proximal and distal ends.

attempts were made with a 5F Bern catheter and stiff hydrophilic wire to cross the occluded left common iliac vein without success.

Venography was performed in different obliquities in an attempt to find a channel that resembled the occluded left external iliac vein. Oblique femoral venography showed a very diminutive venous collateral representing the ascending lumbar vein, a branch of the left common iliac vein (▶ Fig. 7.3c). Accessing the channel to this venous branch, a 5F Quick-cross catheter (Spectranetics, Colorado Springs, CO) was used with a hydrophilic wire to traverse the occluded left common iliac vein. Angioplasty was performed with a 6-mm balloon after which IVUS was used to determine the extent of compression and facilitate stent sizing (▶ Fig. 7.3d). Serial angioplasty was performed up to 16 mm (▶ Fig. 7.3e).

The length of the common iliac and external iliac vein requiring stenting was approximately 16 cm. An 18 mm × 9 cm Wallstent was placed in the left common iliac vein with 1 cm extending into the IVC and was balloon dilated to 16 mm, resulting in a total stent length of 10 cm. A second 16 mm × 9 cm Wallstent with 1 cm of overlap into the left common iliac stent was placed in the left external iliac vein down to but not past the inguinal ligament and ballooned to 16 mm (▶ Fig. 7.3f). IVUS was repeated and showed significant improvement in iliac vein diameter, completion venography was performed, and hemostasis was achieved with manual pressure.

There were no postprocedure complications. The patient was extubated, the bladder catheter removed, and the patient transferred to recovery. The patient was admitted to ensure that there were no postprocedure complications; pain was adequately controlled, and anticoagulation was appropriately administered.

7.2.6 Follow-up

At a 3-week postprocedure clinic visit, symptoms of CVOD had resolved and she had returned to her normal activity including long-distance running.

7.3 Case Vignette 2

7.3.1 Patient Presentation

A 61-year-old male was referred 3 days after undergoing coronary artery bypass grafting complicated by acute IVC and bilateral iliac vein thrombosis. The patient had been on warfarin for a right lower extremity DVT and, in preparation for surgery, had a Trapease IVC filter (Cardinal Health, Dublin, OH) placed 3 weeks prior to surgery. After examination of the patient and extensive discussions with the cardiac surgery team at our institution, the decision was made to discharge the patient on anticoagulation and compression stocking therapy with follow-up evaluation in interventional radiology (IR) clinic in 4 to 6 weeks, as it was determined that thrombolytic therapy would not be safe in the immediate post–cardiac surgery setting.

One month later, the patient presented to IR outpatient clinic for evaluation. The symptoms of bilateral lower extremity swelling had minimally improved with anticoagulation and stockings. He continued to have significant lower extremity pain and swelling and was unable to stand or ambulate for long periods of time. He had gained nearly 25 lbs from lower extremity edema. The patient felt that his cardiac rehabilitation was compromised due to his symptoms resulting from extensive lower extremity clot burden.

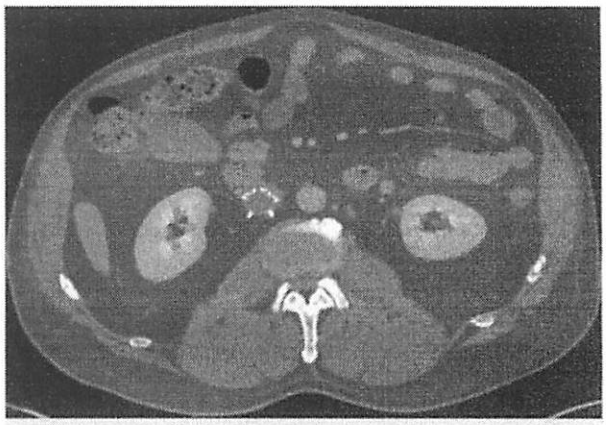


Fig. 7.4 Complete thrombosis of the IVC with permanent Trapease filter in place.

7.3.2 Physical Exam

On physical examination, the patient had significant bilateral lower extremity swelling. His calves were tender to palpation and he was unable to stand for more than a few minutes without developing lower extremity pain and fatigue. He had no obvious skin manifestations, varicosities, or ulcers.

7.3.3 Imaging

A CT venogram demonstrated the permanent IVC filter with occlusive thrombosis of the infrarenal IVC and bilateral iliac veins (▶ Fig. 7.4).

7.3.4 Specifics of Consent

Of particular importance in this case were the risks of stenting across the permanent IVC filter, which included vascular injury, bleeding, and filter fracture or migration. All other benefits and risks as outlined in the first case were also discussed.

7.3.5 Details of Procedure

A preprocedural plan was formulated to ensure the best possible outcome. The plan was to gain bilateral common femoral vein access, perform bilateral iliofemoral venography, and traverse the bilateral iliac and IVC occlusions. This would be followed by pharmacomechanical thrombectomy up to the level of the filter. The IVC and iliac veins would then be reconstructed with Wallstents that would involve "crushing" the filter against the caval wall.

General anesthesia was induced, a bladder catheter placed, and the patient placed in the supine position. Initial access with 10F vascular sheaths was obtained in the bilateral common femoral veins using US guidance. Bilateral lower extremity venograms were performed (▶ Fig. 7.5a). A 5F Bern directional

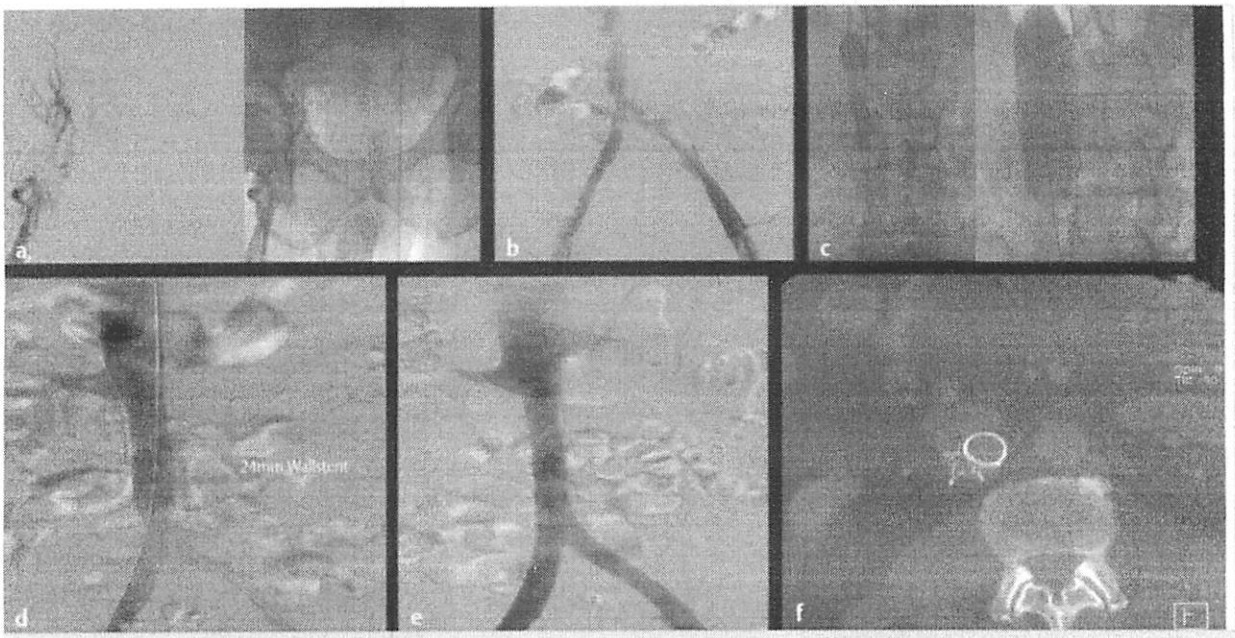


Fig. 7.5 (a) Right lower extremity venogram showing multiple pelvic collaterals due to chronic occlusion of the right iliac veins. The left lower extremity venogram (not pictured) looks the same. (b) Reestablishment of flow into the iliac veins and IVC after pharmacomechanical thrombectomy and angioplasty. (c) Trapease filter is crushed with 24-mm balloon again IVC wall. (d) Recanalized IVC after placement of 24 mm × 7 cm Wallstent. Note that the stent does cover the renal veins. (e) Final venogram showing reconstruction of the IVC and iliac veins. (f) Cone-beam CT shows compression of the IVC filter against the caval wall by the Wallstent with no evidence of vascular injury or hematoma.

catheter, stiff hydrophilic wire, and 5F Quick-cross catheter were used to traverse the occlusions in the bilateral common femoral and iliac veins and distal IVC. The right internal jugular vein was then accessed and a long 12F braided sheath was placed. A stiff hydrophilic wire was used to cross the chronically occluded IVC filter. From the left common femoral vein access, the wire was snared and through and through wire access was established.

Pharmacomechanical thrombectomy with the Angiojet thrombectomy device (Boston Scientific, Marlborough, MA), using pulse spray, was performed in both iliac veins and IVC through the filter. To minimize hemoglobinuria and potential renal injury, thrombectomy of the iliac veins and IVC was limited to a total volume of 300 mL. Repeat venography was performed that showed a moderate thrombus reduction, reestablishment of flow, and significant long-segment stenoses in the bilateral common and external iliac veins, treated with 14- and 16-mm angioplasty balloons (▸ Fig. 7.5b). Through the 12F sheath, a 24-mm balloon was used to "crush" the IVC filter against the caval wall (▸ Fig. 7.5c). This was then followed by placement of a 24 mm × 7 cm Wallstent in the IVC spanning the length of the IVC filter and crossing the renal veins. The stent was deployed and ballooned to 24 mm. Repeat venography showed reestablishment of flow in the IVC (▸ Fig. 7.5d). The bilateral common iliac veins were stented with 14 mm × 9 cm Wallstents and the external iliac veins were stented with 14 mm × 6 cm Wallstents. Repeat venography showed brisk flow through both lower extremities and the IVC with no evidence of contrast extravasation (▸ Fig. 7.5e). In addition, cone-beam CT was performed and showed exclusion of the IVC filter and no evidence of hematoma or filter fracture (▸ Fig. 7.5f). Hemostasis was achieved with manual pressure.

There were no postprocedure complications. The patient was extubated, the bladder catheter was removed, and the patient was transferred to recovery. Due to the complexity of the procedure, he was admitted for 2 days to ensure that there were no postprocedure complications; pain was adequately controlled, and anticoagulation was appropriately administered.

7.3.6 Follow-up

One-month postprocedure, the patient was doing extremely well with minimal lower extremity swelling. His exercise tolerance had significantly increased and he had lost 45 lbs of fluid weight. CT venogram showed that his IVC and iliac stents were patent. One-year postprocedure, the patient continued to do well and remained on anticoagulation. He is currently being evaluated for superficial venous insufficiency in his right lower extremity due to ongoing symptoms of leg fatigue, cramps, and heaviness.

7.4 Epidemiology and Scope of the Problem

PTS affects nearly half of all patients with acute proximal DVT within the first 2 years. About 5 to 10% of patients with symptomatic proximal DVT will develop severe PTS, including venous ulceration, which results in significant disability and impaired quality of life (QOL).[1] Iliofemoral DVT confers a greater risk of

recurrent DVT and thereby a higher risk of PTS compared to femoral-popliteal DVT due to the lack of collateral outflow from the deep femoral.[3,4] Calf DVT, not a completely benign process in its own right, can extend to involve more proximal veins in 10 to 20% of patients and lead to PTS in nearly 20% of those patients.[5] QOL studies have shown that severe PTS has a QOL similar to that of cancer or congestive heart failure.[6] While few studies have examined the costs differentiating acute DVT from its complications, the estimated medical cost of treating VTE and its complications in the United States is $6.7 to $9.8 billion per year.[7]

7.4.1 Patient Presentation and Evaluation

Patients who present with CVOD demonstrate PTS of varying severity. During the initial office consultation, the natural history of DVT and PTS is discussed. Patients are evaluated according to both CEAP classification and VCSS scoring to determine baseline presentation and severity of symptoms. Other factors that are considered are the overall health of the patient and coexisting medical conditions that would complicate a procedure, such as renal insufficiency, heart failure, and morbid obesity. A thorough physical examination is performed and preprocedural photographs of the affected extremities are taken for the medical record. If diagnostic imaging has not been previously performed, duplex US or, most commonly, cross-sectional imaging with either MR/CT venography is performed.

Patient suitability for moderate sedation is assessed. Factors that may require general anesthesia include a plan for extensive recanalization of the deep venous system (i.e., IVC and bilateral iliac vein occlusion vs. single common femoral vein occlusion), the need for assisted ventilation (i.e., CPAP or BIPAP), and pain tolerance and anxiety level.

A critical factor in determining whether a patient is suitable for treatment is likelihood of compliance with anticoagulation, as this is paramount to a successful outcome. Those patients who are noncompliant with medications, including history of compliance with anticoagulation, or who are not suitable candidates for deep vein recanalization may be treated with conservative therapy, including referrals as needed to hematology or lymphedema specialists.

7.4.2 Preparation for Procedure

Low-molecular-weight heparin (LMWH; enoxaparin) is started 48 hours prior to the procedure and continued through the day of the procedure. This move away from using unfractionated heparin has anecdotally led to decreased on-table thrombosis, improved efficiency for the IR and floor nursing staff due to the lack of monitoring activated clotting times (ACTs) or partial thromboplastin time (PTT), and fewer subtherapeutic blood levels in the 1 month postprocedural period, which is the most susceptible rethrombosis period. In cases in which the patient will also be undergoing a complex IVC filter retrieval, unfractionated heparin may be preferable, should quick reversal be needed with protamine for caval injury.

On the day of the procedure, patients are kept NPO. Depending on the proposed length of the procedure, which can range from 2 to 6 hours, a decision is made for bladder catheterization. The patient is placed in either the supine or prone position and US evaluation is performed to determine the ideal access point. Commonly used equipment includes:

- Sheaths (6–16F) including long braided support sheaths.
- Hydrophilic and stiff 0.018- and 0.035-inch guidewires.
- Angioplasty balloons ranging from 4 mm for a tibial vein to 25 mm for an IVC. Balloons (120-cm working length) are often needed when working from a calf vein access.
- Angled catheters (4–5F) and chronic total occlusion catheters.
- Mechanical thrombectomy devices:
  - Angiojet (Boston Scientific, Marlborough, MA).
  - Arrow Trerotola thrombectomy device (Teleflex, Wayne, PA).

In addition to preprocedural antibiotics and moderate sedation medications, nursing staff are advised to keep atropine, protamine, heparin, and nitroglycerin readily available.

7.4.3 Technical Tips and Tricks and Procedural Details

Preprocedural planning to determine the ideal access point and the major steps in the procedure is one of the most important components of performing a deep venous recanalization procedure. Common access points such as the popliteal vein, common femoral vein, and internal jugular veins are evaluated. US is used to determine the most peripheral part of the extremity in which a patent deep vein is visualized. For example, if a patient has chronic thrombus involving the popliteal vein, access is achieved in a patent deep vein segment peripheral to the level of the occlusion, such as the posterior tibial or peroneal vein, to maximize venous inflow and recanalize the full length of the popliteal vein. Occasionally, the small saphenous vein may be used if it joins a patent popliteal vein segment.

7.4.4 Potential Complications or Pitfalls

The complications from deep venous recanalizations are few and generally not life-threatening. Venous rupture is a common and easily managed complication treated with prolonged balloon tamponade and, in rare cases, a stent. More challenging technical complications include stent undersizing that can lead to rethrombosis, or oversizing that can result in intractable back pain, especially in left common iliac vein stenting in May-Thurner syndrome. While IVUS can be beneficial for stent sizing and for evaluating major and subclinical areas of venous stenosis, its use is not an absolute requirement in our experience if good quality multiplanar venography is performed.

7.4.5 Postprocedural Management and Follow-up

Having a well-defined management plan that deals with anticoagulation issues, rethrombosis, pain, and ongoing postthrombotic symptoms is key to a successful outcome in the eyes of the patient. Shortly before the end of the procedure, the heparin infusion is stopped and an ACT is checked before removal of the sheaths (sheaths removed if ACT < 200 sec). If the patient is

on LMWH, the sheaths are removed without checking any parameters. Once hemostasis is achieved, the patient is transferred to and observed in the recovery room.

Depending on the complexity of deep vein recanalization, the patient is either discharged the same day or admitted for overnight observation. In some cases, patients are admitted for 1 to 2 days if they have other comorbidities such as renal insufficiency or congestive heart failure that may require further monitoring. All patients are admitted to the IR service.

If patients are admitted, nursing staff are instructed to monitor the patient for access site complications and pain control and to ensure that anticoagulation is maintained.

Anticoagulation with LMWH is restarted the same day if the patient is on heparin during the procedure. Compression garments should be fitted and obtained prior to the day of the procedure. If the patient does not have appropriate compression stockings, a lymphedema team, if available, should be consulted for compression garments to be fitted within 24 hours of the procedure.

Prior to discharge, the patient is examined for access site complications and pain control, and relevant bloodwork is reviewed. Thigh-high compression stockings, 20 to 30 mm Hg, should be worn daily for 1 month until first office follow-up. Office visits are performed at 1, 6, and 12 months postprocedure. Imaging, consisting of duplex US or CT venography, is performed at 1-month postprocedure for patients with infrainguinal disease and IVC/iliac thrombosis, respectively. Additional imaging is generally not needed at subsequent follow-up unless there is a concern for rethrombosis or PTS symptoms recur that may necessitate a repeat intervention. Patients are generally discharged with a 1-month supply of twice-daily dosing of LMWH and a narcotic for pain. Since the degree of initial venous occlusion correlates with the likelihood of developing reflux, patients are followed yearly for signs and symptoms of superficial venous insufficiency and, if clinically indicated, are treated with saphenous vein ablation.[8]

If available, it is beneficial to work with a multidisciplinary thrombosis service on all patients presenting with acute and chronic DVT. Hematologists should be familiar with relevant procedures, and protocols for managing patients with CVOD may be developed collaboratively. In the process of building this relationship, all parties have an opportunity to learn about thrombosis and its complications. It can be useful for patients to have a follow-up appointment with a hematologist, who will monitor and make recommendations regarding anticoagulation after the 1 month of LMWH.

The American College of Chest Physician guidelines are a useful guide regarding the duration and type of anticoagulation. Use of an antiplatelet agent in conjunction with anticoagulation may confer higher risk of bleeding than do anticoagulants, alone, and there is lack of evidence for an antiplatelet/anticoagulation regimen in venous disease. However, once patients have completed their course of anticoagulation, aspirin 81 mg daily may be useful as secondary prevention against recurrent thrombosis.

7.4.6 Outcomes

With the advent of endovascular techniques, the options available for patients with severe CVOD have expanded. Nearly two decades ago, Nazarian et al described their experience in stenting IVC and iliofemoral occlusions with primary and secondary 1-year patency rates of 50 and 81% and 4-year patency rates of 50 and 75%, respectively.[9] More recently, in patients with iliofemoral CVOD, Razavi et al performed a meta-analysis of 37 studies including 2,869 patients (nonthrombotic, 1,122; acute thrombotic, 629; chronic postthrombotic, 1,118) that underwent stenting and found a high rate of stent patency and minimal complication rate. At 1 year, primary and secondary patency rates were 96 and 99% for nonthrombotic, 87 and 89% for acute thrombotic, and 79 and 94% for chronic postthrombotic.[10] While limited retrospective series have shown promising outcomes in the management of CVOD, presently there are no prospective randomized studies comparing these procedures to conservative measures. However, many patients who seek medical attention for severe PTS have been unable to receive adequate, if any, medical attention for CVOD and thereby have been suffering for years with more conservative therapies (i.e., compression stockings) that are often difficult to maintain long term.

7.5 Pearls of Wisdom

- Be persistent. These cases can be very long and challenging. Sometimes you will need to bring the patient back another day and try again.
- Make sure the patient is adequately anticoagulated during the procedure; otherwise, rethrombosis will occur on the table or shortly thereafter.
- Have a low threshold for using a crossing catheter to traverse an occlusion. It can mean the difference between minutes and hours.
- Patients may complain of back pain after stenting in May-Thurner syndrome. If back pain continues for more than a week, a short, tapering course of steroids is often helpful to decrease pain and inflammation.
- Maximize inflow by obtaining access at a location peripheral to the occluded vein segment.
- Avoid telling the patient that their swelling and other postthrombotic symptoms will resolve within a few days of venous recanalization. Often, it can take 4 to 6 weeks for patients to notice a significant improvement.
- If unsuccessful in recanalization attempt, consider sending patient to a more experienced center.

7.6 Unanswered Questions

CVOD is a non-life-threatening condition that is often inadequately treated from a patient QOL perspective. Patients with PTS are often not referred to an appropriate vascular specialist because there is a widespread lack of understanding about venous disease and available treatments. The care of patients with PTS often requires a multidisciplinary approach including but not limited to IR, hematology, surgery, podiatry, lymphedema specialists, and physical therapy.

Areas that require further research include:

- Investigating the natural history of PTS in those with calf or isolated popliteal DVT.

- Examining the role of venous inflow and its effect on recurrent thrombosis rates.
- Identifying the optimal anticoagulation/antiplatelet regimen after venous recanalization.
- Appropriate timing for thrombolysis/recanalization in the setting of recent surgery.
- Stent sizing optimization.

References

[1] Baldwin MJ, Moore HM, Rudarakanchana N, Gohel M, Davies AH. Post-thrombotic syndrome: a clinical review. J Thromb Haemost. 2013; 11(5):795–805

[2] Guanella R, Ducruet T, Johri M, et al. Economic burden and cost determinants of deep vein thrombosis during 2 years following diagnosis: a prospective evaluation. J Thromb Haemost. 2011; 9(12):2397–2405

[3] Tick LW, Kramer MH, Rosendaal FR, Faber WR, Doggen CJ. Risk factors for post-thrombotic syndrome in patients with a first deep venous thrombosis. J Thromb Haemost. 2008; 6(12):2075–2081

[4] Douketis JD, Crowther MA, Foster GA, Ginsberg JS. Does the location of thrombosis determine the risk of disease recurrence in patients with proximal deep vein thrombosis? Am J Med. 2001; 110(7):515–519

[5] Meissner MH, Caps MT, Bergelin RO, Manzo RA, Strandness DE, Jr. Early outcome after isolated calf vein thrombosis. J Vasc Surg. 1997; 26(5):749–756

[6] Kahn SR, Ducruet T, Lamping DL, et al. Prospective evaluation of health-related quality of life in patients with deep venous thrombosis. Arch Intern Med. 2005; 165(10):1173–1178

[7] Grosse SD, Nelson RE, Nyarko KA, Richardson LC, Raskob GE. The economic burden of incident venous thromboembolism in the United States: A review of estimated attributable healthcare costs. Thromb Res. 2016; 137:3–10

[8] Markel A, Manzo RA, Bergelin RO, Strandness DE, Jr. Valvular reflux after deep vein thrombosis: incidence and time of occurrence. J Vasc Surg. 1992; 15(2):377–382, discussion 383–384

[9] Nazarian GK, Bjarnason H, Dietz CA, Jr, Bernadas CA, Hunter DW. Iliofemoral venous stenoses: effectiveness of treatment with metallic endovascular stents. Radiology. 1996; 200(1):193–199

[10] Razavi MK, Jaff MR, Miller LE. Safety and effectiveness of stent placement for iliofemoral venous outflow obstruction: systematic review and meta-analysis. Circ Cardiovasc Interv. 2015; 8(10):e002772