Journal of Radiology Nursing 38 (2019) 158–163

Contents lists available at ScienceDirect

Journal of Radiology Nursing

journal homepage: www.sciencedirect.com/journal/journal-of-radiology-nursing

Catheter-Directed Thrombolysis in the Setting of Massive Iliofemoral Deep Vein Thrombosis: Case Study and Review

Sagar Desai, BS [a,*], Samy Dhurairaj, MD [b], Jason Glass, RT(R) [b], Connie Donnelly, RN [b], David Sacks, MD [b]

[a] *Medical Student MS4, Philadelphia College of Osteopathic Medicine*
[b] *Department of Interventional Radiology — Tower Health Medical Group, Reading, PA*

Keyword:
Catheter-directed thrombolysis
Deep vein thrombosis
Pharmacomechanical thrombolysis
Venous thromboembolism

A B S T R A C T

Catheter-directed thrombolytic (CDT) therapy has steadily grown in popularity as the primary intervention for certain types of acute or subacute deep vein thrombosis. In such cases, nurses within the interventional radiology department must sustain patient care during all phases of the procedure while also monitoring progression of clot lysis and different CDT therapies used by the physician. This article describes the 3-day treatment and management of a patient presenting with extensive bilateral iliofemoral thrombosis. Relevant anatomy, indications for CDT therapy, and specific nursing considerations are reviewed.

Introduction

Background

Venous thromboembolism (VTE) includes both asymptomatic and symptomatic deep vein thrombosis (DVT), as well as pulmonary embolism (PE) (Porter & Moneta, 1995). VTE affects an estimated 350,000 to 600,000 Americans per year, making it the third most common cardiovascular pathology after coronary artery disease and stroke. VTE is often fatal, with an estimated 10-30% mortality within 30 days of disease diagnosis (Beckman & et al., 2010). The incidence of VTE is projected to increase due to longer life spans, increasing obesity, and increasing hospital admissions. Furthermore, the utilization of catheter-directed thrombolytic (CDT) therapy has increased from 2.3% in 2005 to 5.9% in 2010 in patients with acute proximal (above the calf) DVT (Bashir & et al., 2014).

VTE disease can be thought of as a continuum: (1) clot formation within the deep veins, (2) clot propagation leading to symptomatic swelling, erythema, and warmth, and (3) clot embolization with subsequent occlusion of pulmonary vasculature. The primary goal of management in a patient with DVT is to prevent thrombus extension with the use of anticoagulation. Anticoagulation, however, does not remove the existing clot. Patients who have already developed DVTs may not clear the clot physiologically. Therefore, treatment techniques such as surgical thrombectomy and thrombolytic therapy have been developed to remove existing clot with the intention of more rapidly improving symptoms, preventing later post-thrombotic syndrome (PTS) from venous valve damage and reducing the risk of PE. In patients with a contraindication to anticoagulation, an inferior vena cava (IVC) filter may be placed to reduce the risk of PE (Bjarnason, 2006; Hirsh, 2002).

This article presents an interesting case involving a patient with massive, bilateral iliofemoral venous thrombosis successfully treated with CDT therapy using unilateral access. The patient's inability to tolerate prone positioning due to morbid obesity and distal venous occlusions prevented usage of standard techniques. We will address relevant anatomy, present the case in a day-by-day manner, discuss CDT therapy indications, IVC filter issues, and review specific nursing considerations.

Relevant Anatomy

The veins draining the lower extremity (Figure 1) are divided into a superficial group and deep group (Agur, 2019; Moore, 2019). The superficial group contains smaller caliber veins located within subcutaneous connective tissue. They are intricately interconnected and drain into two major channels: the great saphenous vein (GSV) and small saphenous vein. The GSV spans the entirety of the leg, ascending medially from the dorsal arch of the foot up to the proximal femoral vein.

Meeting Where Presented: None.

* Corresponding author: Sagar Desai, Medical Student MS4, Philadelphia College of Osteopathic Medicine, 1093 Woodberry Drive, Mountain Top, PA 18707.
E-mail address: sagarde@pcom.edu (S. Desai).

https://doi.org/10.1016/j.jradnu.2019.07.002
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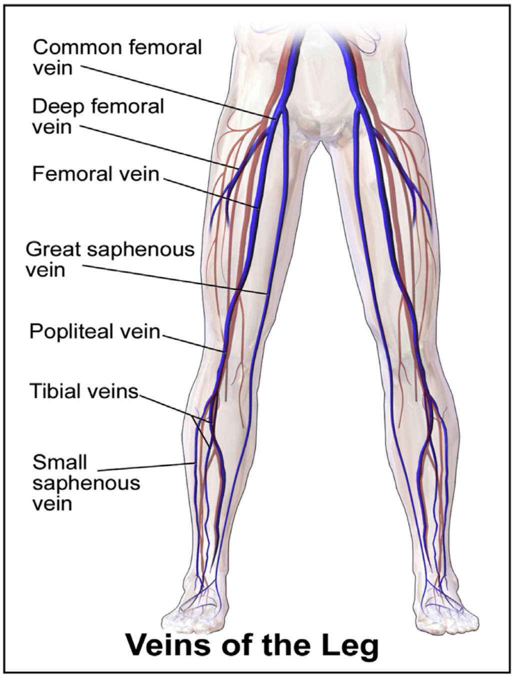

Figure 1. Venous system of lower extremity. "Medical gallery of Blausen Medical 2014". *WikiJournal of Medicine*. 1(2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436. https://en.wikiversity.org/w/index.php?title=WikiJournal_of_Medicine/Medical_gallery_of_Blausen_Medical_2014&printable=yes#Other_circulatory.

Veins within the deep group are independently named (i.e., tibial, popliteal, femoral, iliac) and generally follow their corresponding major arteries. The major vein draining the leg is the femoral vein: it receives flow from the popliteal vein distally and is joined by the profunda (deep) femoral vein and GSV proximally where it may be referred to as the common femoral vein (CFV). The CFV becomes the external iliac vein when it passes under the inguinal ligament to enter the abdomen. The external iliac is joined by the internal iliac, which drains the deep pelvic organs, to form the common iliac vein. The two common iliac veins combine, approximately at the level of the 5th lumbar vertebra, to form the IVC.

Case

Initial Presentation

A 76-year-old morbidly obese female presented to her primary care physician on a Thursday afternoon with complaints of nausea, diarrhea, abdominal bloating, lower back pain, and right leg pain. A computed tomography (CT) scan of her abdomen and pelvis revealed extensive thrombosis of both femoral veins through to mid and distal IVC. The clot extended into an OptEase IVC filter (Cordis, Santa Clara, CA), which was placed 30 years prior secondary to DVT while on oral anticoagulation. The patient was not currently anticoagulated.

Day 1

- Obtaining vascular access was quite difficult. The right popliteal vein could not be accessed because of body habitus, rendering the patient unable to tolerate prone positioning. A 21 G needle accessed the right posterior tibial vein; however, a guidewire could not be advanced because of complete, chronic clot occlusion. Access to a large caliber collateral of the GSV was obtained below the right knee; however, multiple attempts to advance the catheter into the deep vein failed because of tortuosity of the subcutaneous veins.
- Attention was directed to the left leg; ultrasound showed a posterior tibial vein too small for instrumentation; therefore, GSV access at the anteromedial aspect of the proximal left leg was obtained. Initial left lower extremity venography showed no clot within the GSV, CFV, or external iliac vein. Subsequent pelvic venography showed complete occlusion of the left common iliac vein and distal IVC, with a large collateral providing venous drainage to the IVC superior to the pre-existing filter (Figure 2A).
- A 6-Fr AngioJet Solent catheter (Boston Scientific, Marlborough, MA) was coaxially advanced to the distal IVC, and 10 mg of tissue plasminogen activator (tPA) mixed with 250 mL saline was instilled within clot using the power-pulse spray method. Aspiration thrombectomy was performed; however, extensive clot burden still remained (Figure 2B).
- A decision was made to use the left lower extremity access to treat the right-sided DVT as well. A glidewire and vascular catheter were advanced in a retrograde manner over iliac bifurcation and into right femoral vein. Complete occlusion of the right-sided venous system was evident. tPA instillation and AngioJet pharmacomechanical thrombectomy were again performed with minimal improvement seen (Figure 2C).
- A 5-Fr catheter with a 40 cm long infusion segment was advanced over the IVC bifurcation. The distal side hole was placed in the right CFV and the proximal side hole in the left external iliac vein to perform simultaneous bilateral lysis. The catheter was connected to a 1 mg/hr tPA infusion overnight, and full dose systemic heparin (16units/kg/hr) was administered through the side port of the left GSV sheath.

Day 2

- Venography after overnight infusion demonstrated recanalization of the left common iliac vein with residual nonocclusive filling defects (Figure 3A). Slight contrast filling within the previously identified collateral vein was still evident.
- Partial recanalization of the right common iliac vein was achieved; however, there was persistent clot burden distally. tPA instillation and AngioJet-assisted pharmacomechanical thrombectomy was performed within the right external iliac and femoral veins (Figure 3B).
- A 5-Fr thrombolysis catheter with a 20-cm length infusion segment was placed and infused overnight with 0.5 mg/hr tPA. Full dose systemic heparin infusion was continued.

Day 3

- Contrast injection through the infusion catheter showed antegrade flow through the right external and common iliac veins, with nonocclusive clot remaining in the right femoral vein (Figure 4C).
- Contrast injection through the vascular sheath showed prompt venous flow through the left common iliac vein, IVC, and IVC filter, with nonocclusive clot remaining below the filter (Figure 4A and 4B).
- With rapid bilateral deep venous blood flow, thrombolysis was discontinued and the catheter was removed. The patient was discharged home with oral blood thinners.

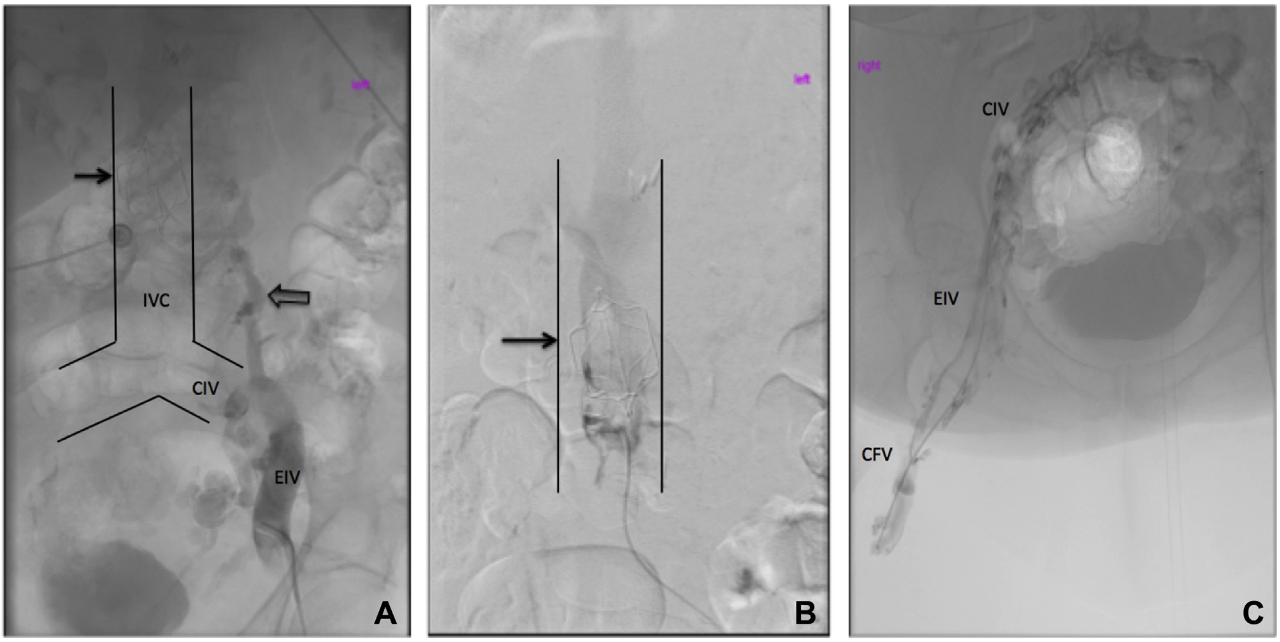

Figure 2. Day 1 intraoperative venography. Thin arrow = IVC filter; thick arrow = collateral vein. IVC = inferior vena cava; EIV = external iliac vein; CIV = common iliac vein; CFV = common femoral vein. (A) Left iliofemoral venography, (B) IVC venography, (C) right iliofemoral venography.

Discussion

Indications for Catheter-Directed Thrombolysis

DVT management is debated among physicians because of new clinical trials and improving thrombolytic technique. Early results comparing CDT therapy and anticoagulation versus anticoagulation alone were very favorable. An early clinical trial (2002) showed that CDT therapy resulted in significantly higher venous patency and lower venous reflux rates (Elsharawy & Elzayat, 2002). The Norwegian CaVenT trial (2012) reported that CDT therapy of iliofemoral DVTs resulted in significant, long-term risk reduction of PTS (Enden & et al., 2009).

However, the multicenter NIH-funded ATTRACT trial (2016), considered a landmark study, demonstrated that long-term development of all PTS was not lower in the overall group of patients treated with CDT therapy (Suresh & et al., 2017). Of note, however, for patients with iliofemoral DVT, there were statistically significant reductions in the CDT group in the incidence of severe PTS (12% vs 6.5%) with better improvement in pain and leg circumference with CDT at 10 and 30 days and greater improvement in disease-specific quality of life. There was a nonsignificant higher risk of major

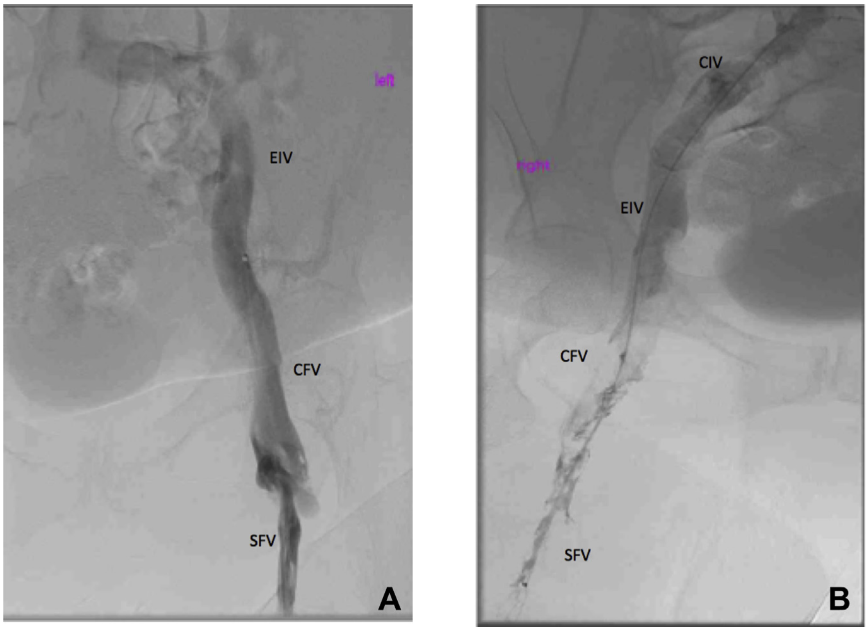

Figure 3. Day 2 intraoperative venography. CIV = common iliac vein; EIV = external iliac vein; CFV = common femoral vein; SFV = superficial femoral vein. (A) Left iliofemoral venography, (B) right iliofemoral venography.

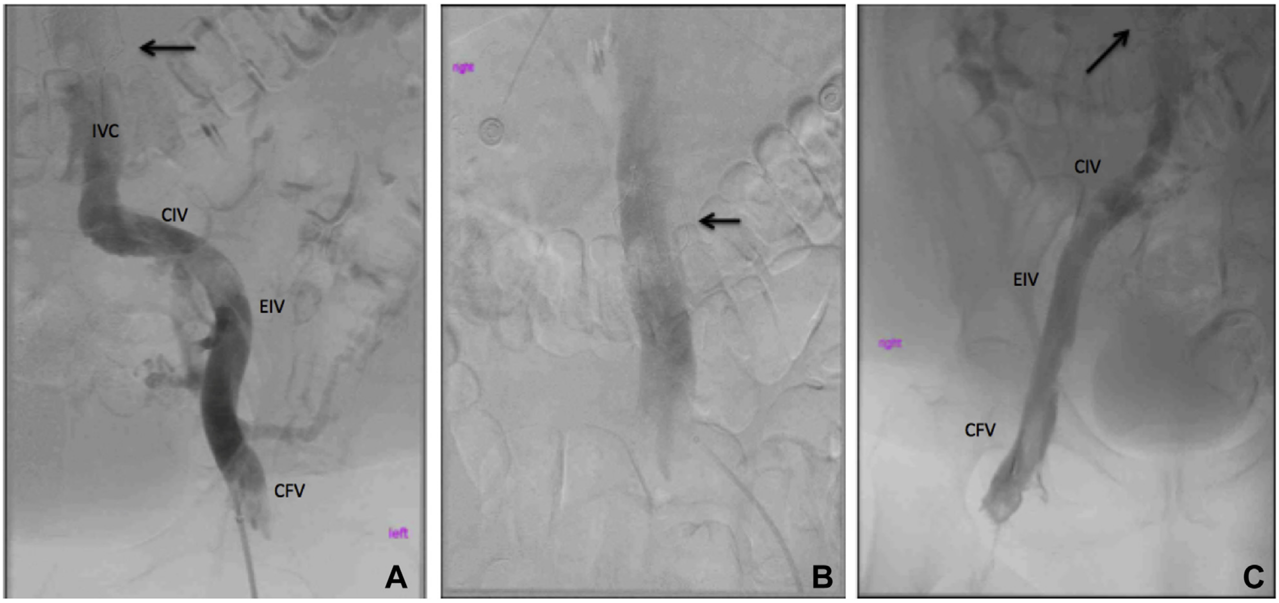

Figure 4. Day 3 intraoperative venography. Arrow = IVC filter. IVC = inferior vena cava; CIV = common iliac vein; EIV = external iliac vein; CFV = common femoral vein. (A) Left iliofemoral venography, (B) IVC venography (C) right iliofemoral venography.

bleeding events with CDT therapy (1.5% vs 0.5%, p = .32) (Comerota & et al, 2019). As a result, there has been a shift in patient management away from elective CDT procedures with the exception of iliofemoral DVT.

Today, DVT management remains physician and hospital-protocol dependent with CDT therapy commonly used for severe swelling that is threatening acute limb ischemia, also known as phlegmasia cerulea dolens, and massive IVC and iliofemoral thrombosis. Figure 5, adapted from national society recommendations (Kearon & et al., 2016; Meissner & et al., 2012; Vedantham & et al., 2014), illustrates physician thought processes when determining the best course of treatment for patients presenting with large iliofemoral DVTs.

In the patient described within this article, her morbid obesity already increased her future risk of VTE disease (Beckman & et al., 2010). With massive bilateral iliofemoral and caval DVT, she was felt to be a reasonable candidate for CDT therapy.

IVC Filter Issues

IVC filters are effective in preventing acute PE, but they have been associated with a long-term increased risk of DVT and IVC thrombus. The PREPIC trial studied 8-year outcomes of patients with proximal DVTs who were given anticoagulation plus IVC filter versus anticoagulation alone. They determined that the IVC filter group had significantly fewer PE's (6.2% vs 15.1%, p = .008); however, they had significantly more symptomatic DVTs (35.7% vs 27.5%, p = .042). Furthermore, at the conclusion of the study, there was no difference in patient mortality in either treatment groups (PREPIC Study Group, 2005). Results of this trial, along with studies documenting filter fragmentation and possible embolization (An & et al, 2014), have led to U.S. Food and Drug Administration recommendations that filters be removed when no longer needed (Morales & et al., 2013).

IVC filter placement and management may be physician and case dependent. Some societies recommend filter placement only in patients with DVT and a contraindication to anticoagulation (Pablo & et al., 2012). There is still divided opinion, and more research is necessary, regarding extended indications for IVC filter placement in trauma patients (Haut & et al., 2014). Some physicians recommend chronic anticoagulation in patients simply to prevent complications if a filter is not removed (Ray & Allan, 2007).

Many filters in current use are structurally designed to allow retrieval. Despite this, even in patients whose need for a filter is temporary, it is common that the filter is not removed, usually because of lack of follow-up. A multicenter study found that fewer than half of patients undergo attempted filter removals (Ray & et al., 2006). In the patient described in this article, she had received a retrievable OptEase filter 30 years earlier at another hospital, which was not removed for unknown reasons. It is not possible to know if the filter caused her extensive DVT or if the filter prevented her from having a potentially fatal PE. It was not removed after her DVT procedure because it was likely to be fully incorporated into the wall of her IVC.

Nursing Considerations

Periprocedural Care

Nursing care immediately before and after CDT therapy is similar to other percutaneous cardiac and peripheral interventions. Emphasis is placed on blood pressure, heart rate, hemoglobin, platelet count, prothrombin time/INR, activated partial thromboplastin time, and fibrinogen levels because of the risk of bleeding.

Procedural Care

Patient monitoring within the interventional suite is affected by the technique of CDT therapy used (Rich, 2015). Simple CDT therapy involves no more than catheter placement and then lytic infusion. Ultrasound accelerated CDT therapy using the EKOS system (EKOS Corporation, Bothell, WA) also involves catheter placement, but the catheter is attached to the lytic infusion, an intracatheter ultrasound, and a cooling flush. The AngioJet device can cause symptomatic bradycardia, which usually resolves when the device is turned off but can produce asystole, particularly when used in the pulmonary artery to treat PE (Dwarka & et al., 2006), leading to an FDA black box warning (Kuo & et al., 2009). The AngioJet and large diameter suction embolectomy devices, such as the Penumbra Indigo System (Penumbra Inc., Alameda, CA), can produce blood loss when aspirating in patent areas of the vein. Rotating baskets, such as the Arrow Trerotola PTD (Teleflex, Morrisville, NC) or the Argon

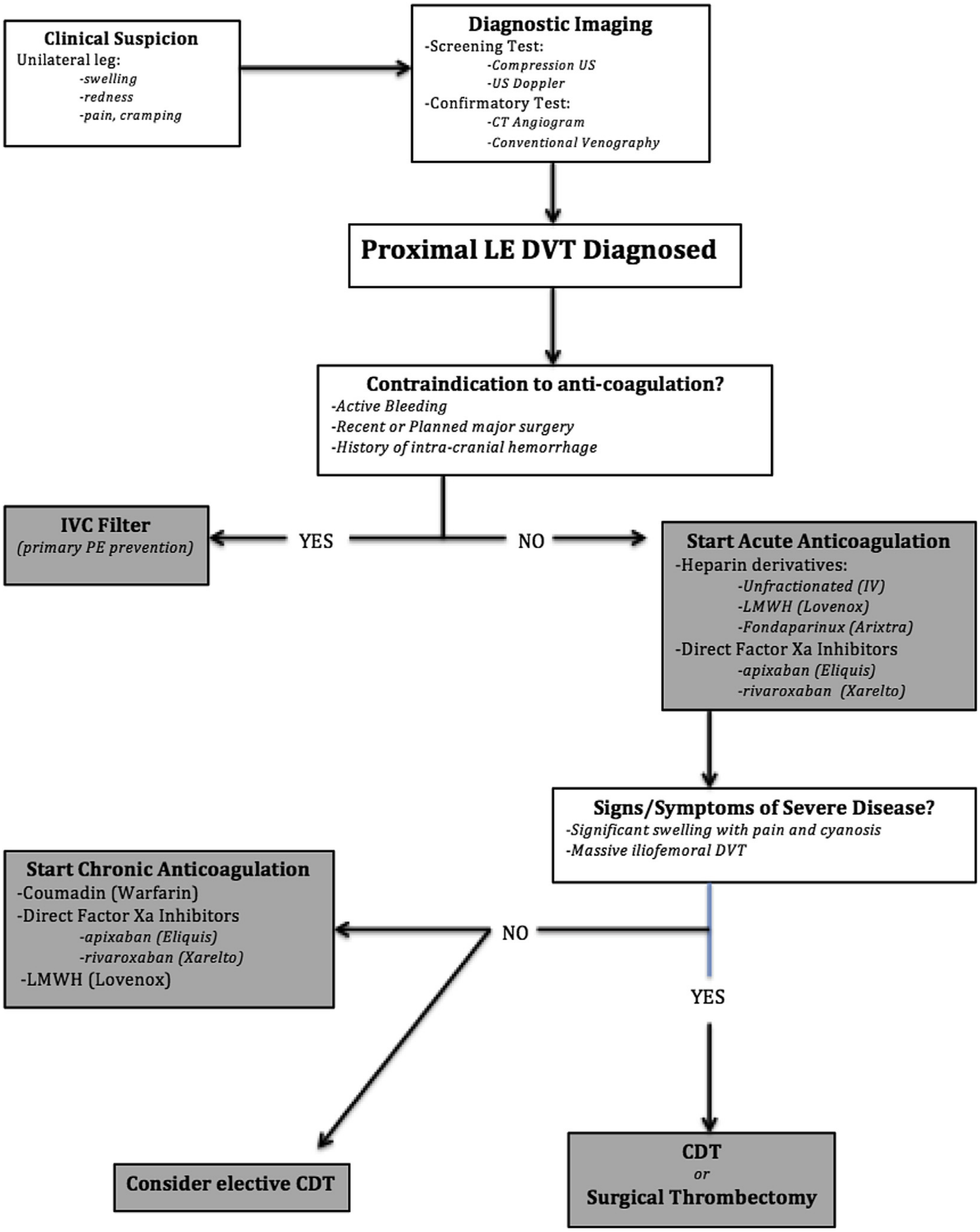

Figure 5. Structural outline regarding clinical management of proximal lower extremity deep vein thrombosis. US = ultrasound; CT = computed tomography; DVT = deep vein thrombosis; LE = lower extremity; IVC = inferior vena cava; PE = pulmonary embolism; CDT = catheter-directed thrombolytic.

cleaner (Argon Medical, Frisco, TX), will fragment clots that can lead to pulmonary emboli causing rapid oxygen desaturation and hypotension. Very large aspiration systems, such as the AngioVac (AngioDynamics, Latham, NY), require cardiopulmonary bypass.

Postprocedural Care

Considerations can be broken down into 3 main areas of focus (Bussard, 2002):

Patient Assessment and Monitoring

- In addition to all regularly scheduled nursing assessment parameters, special attention must be given for signs of hemorrhage (secondary to thrombolytic medication). Risk of hemorrhage is low (1.7% overall in the ATTRACT trial) but is felt to increase with increased lytic doses and longer durations of infusion (Suresh & et al., 2017). The risks of bleeding are sufficiently low enough that in many hospitals these patients are treated in step down nursing units rather than in intensive care units. The bleeding risks associated with systemic doses of lytics used for acute stroke (up to 90 mg of tPA over 60 minutes) include a 6% incidence of intracranial hemorrhage (The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group, 1995), but intracranial bleeding is exceedingly rare with the low doses of 0.5-2 mg tPA/hr used for CDT therapy, with no such bleeds in the 337 CDT therapy patients in the ATTRACT trial (Suresh & et al., 2017).

- We recommend specific surveillance for hematuria, hemoptysis, hematochezia, venipuncture site bleeding or expanding hematoma, and focal neurological deficits. The AngioJet will cause red blood cell fragmentation and hemoglobin release, which is excreted in the urine, giving the appearance of hematuria. Nurses need to be aware of the expected appearance of red urine. Rarely will the extent of hemoglobinuria cause acute renal injury (Shen & et al., 2019). This risk can be reduced with hydration during and after the procedure.

Maintenance of Catheter and Delivery System

- It is important to maintain awareness and priority while properly securing the catheter access site. Improper movement by the patient, family members, or hospital personnel may displace the endovascular infusion segment, resulting in clot embolism and ineffective tPA delivery.

- Attention should be directed toward the verification of the medication, dosage, and infusion rate and proper device function during extended overnight tPA infusions. It is important not to let the tPA infusion run out between replacement bags.

Patient Education

- Ensure that the patient and family receive standard DVT education including overview of received treatment, future risk factor modification, and outpatient medical therapy information. Outpatient management includes medications, possible dietary modifications, use of compression stockings, and continued care with a general practitioner and/or specialty physicians. Social work or other resources may be necessary to develop a plan to make anticoagulation and follow-up visits more affordable.

- Patients must be educated on the need for strict compliance to medications, concerning signs and symptoms of bleeding from anticoagulation, leg swelling or pain from recurrent DVT, or chest pain and shortness of breath from PE. Particular attention should be given to the medication compliance and the difference between swelling related to PTS and swelling that may indicate a new DVT. Patient education is essential to preventing readmission and improving quality of life for patients who have dealt with massive iliofemoral DVT.

Conclusion

Catheter-directed thrombolysis has become a well-established treatment modality for IVC and iliofemoral DVTs, with expanding indications sure to come in the future. Familiarity with the vascular anatomy, equipment used, and possible complications is necessary for all nursing staff involved with such cases. Furthermore, it is helpful to understand the clinical trials that have shaped the physician decision-making process distinct for each patient. CDT therapy cases, such as the one described, can become arduous multiple-day endeavors; comprehensive knowledge regarding the topic will help in providing exceptional preprocedural patient evaluations and postprocedural care and education.

Conflict of interest

The authors have no conflicts of interest to declare.

Acknowledgment

None.

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