Deep Vein Thrombosis

Most DVT starts in the calf veins. Without treatment, 15% to 30% of these clots propagate to the proximal calf veins. The risk of a subsequent PE is much higher with proximal DVT than with clots confined to the distal calf vessels (40% to 50% vs. 5% to 10%, respectively). Involvement of the upper extremities is much less common, but subclavian or axillary vein thrombosis also can lead to PE in as many as 30% of affected individuals. The same risk factors that cause lower-extremity DVT also cause upper-extremity DVT. In addition, other specific causes of upper-extremity DVT include traumatic damage of the vessel intima due to heavy exertion such as rowing, wrestling, or weight lifting (Paget-Schroetter syndrome), extrinsic compression at the level of thoracic inlet (thoracic outlet obstruction), or insertion of central venous catheters or pacemakers.

Pain and swelling are the major complaints from patients with DVT; however, a large number of patients are asymptomatic, particularly if the DVT is restricted to the calf. Patients with upper-extremity DVT can develop the superior vena cava syndrome of facial swelling, blurred vision, and dyspnea. Thoracic outlet obstruction can compress the brachial plexus, leading to unilateral arm pain associated with hand weakness. Physical examination frequently reveals tenderness, erythema, warmth, and swelling below the site of thrombosis. Pain with dorsiflexion of the foot (Homan's sign) may be present, but the low sensitivity and the low specificity limit the usefulness of this sign in the diagnosis of lower-extremity DVT. A palpable tender cord, dilated superficial veins, and low-grade fever occur in some patients. Upper-extremity DVT can cause brachial plexus tenderness in the supraclavicular fossa and atrophic hand muscles. For patients with probable thoracic outlet obstruction, several provocative tests should be performed. Adson's test is positive if the radial pulses weaken during inspiration and during extension of the arm of the affected side while rotating the head to the same side. Wright's test is positive if the radial pulses become weaker and painful symptoms are reproduced while the shoulder of the affected side is abducted with the humerus externally rotated.

The laboratory diagnosis of DVT includes measurement of D-dimers, which are fibrin degradation products. D-dimer elevation is a highly sensitive indicator of DVT that can be performed rapidly in the emergency department. In a patient in whom the index of probability is low, a negative D-dimer test effectively excludes the diagnosis of DVT. However, the test is not specific and can be elevated in many other conditions frequently encountered in hospitalized patients (e.g., inflammation, recent surgery, malignancy). Duplex ultrasonography can be used to demonstrate the presence of a blood clot or noncompressibility of the affected veins proximal to the site of occlusion. Duplex ultrasonography has greater sensitivity in detecting proximal DVT (90% to 100%) than distal DVT (40% to 90%) of the lower extremities. With upper-extremity DVT, acoustic shadowing of the clavicle may obscure detection of thrombosis in subclavian vein segments. MR angiography is particularly helpful in making the diagnosis of upper-extremity DVT and pelvic vein thrombosis. Contrast venography is the conventional "gold standard" test, but it is invasive and technically difficult in patients with edematous extremities. Therefore, invasive venography should be reserved for patients in whom the clinical suggestion is high despite negative or inconclusive results from noninvasive imaging.

Patients with proximal lower-extremity DVT and those with upper-extremity DVT should be treated initially with subcutaneous low-molecular-weight heparin (LMWH), intravenous or subcutaneous unfractionated heparin (UFH) or the subcutaneous selective factor Xa inhibitor fondaparinux to prevent thrombus propagation and to maintain the patency of venous collaterals (level A evidence). Intravenous UFH should be given as a bolus, followed by continuous infusion to maintain an activated partial thromboplastin time of at least 1.5 times the control value. Both LMWH and fondaprinux have a longer half-life than UFH and can be given once or twice daily with similar efficacy. Oral warfarin should be initiated together with LMWH, UFH, or fondaprinux without delay and titrated until the international normalized ratio (INR) reaches a value between 2 and 3. Alternatively, rivaroxaban, an oral factor Xa inhibitor, may be used without initial parenteral anticoagulation and continued for at least 3 months. Direct thrombin inhibitors such as dabigatran have been shown to be efficacious in this clinical setting and were recently approved for treatment of DVT and pulmonary embolism in the United States. When DVT is confined to the calf, the risk of PE is low, and the risk-to-benefit ratio of anticoagulation remains controversial.

When upper-extremity DVT occurs in young patients who are otherwise healthy, two invasive approaches to thrombus removal should be considered: infusion of a fibrinolytic drug through a catheter inserted directly into the affected vein and mechanical fragmentation of the thrombus via catheter-based technology. The purpose of these invasive procedures is to prevent or minimize the post-thrombotic syndrome, which includes chronic arm pain, swelling, hyperpigmentation, and ulceration from residual venous obstruction.

Catheter-based placement of a filter in the inferior vena cava should be considered for patients with proximal DVT who either have an absolute contraindication to anticoagulation or develop recurrent PE despite an adequate trial of anticoagulation. Vena cava filters are effective in reducing the incidence of PE, but they increase the risk of recurrent DVT. Some proximal or distal migration of the filter occurs in up to 50% of cases; however, clinically evident filter embolization is limited to case reports.

Pulmonary Embolism

PE occurs when a thrombus dislodges from the deep veins of the upper or lower extremities and travels to the lungs. Pulmonary vascular resistance and pulmonary arterial pressure increase from two mechanisms: anatomic reduction in cross-sectional area of the pulmonary vascular bed and functional hypoxia-induced pulmonary vasoconstriction. The pressure overload on the right ventricle can lead to dilation, hypokinesis, and tricuspid regurgitation. Elevated right ventricular end-diastolic pressure, if severe, can compress the right coronary artery, causing subendocardial ischemia. In acute PE, areas of lung tissue are ventilated but underperfused. This $\dot{V}/\dot{Q}$ mismatch and the resultant redistribution of pulmonary blood flow from the obstructed pulmonary artery to other lung regions with lower $\dot{V}/\dot{Q}$ ratios cause arterial hypoxemia. In patients with a patent foramen ovale, hypoxemia