

# Endovascular and Open Surgery for Deep Vein Thrombosis



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## KEYWORDS

- Deep vein thrombosis • Postthrombotic syndrome • Thrombolysis • Thrombectomy
- Angioplasty and stenting

## KEY POINTS

- Catheter-directed thrombolysis is a safe and effective modality for treatment of extensive, typically iliofemoral deep vein thrombosis (DVT) in selected patients.
- Early removal of thrombus restores venous patency, preserves valve function, and can lead to faster relief of symptoms and decrease the long-term risk of severe postthrombotic syndrome.
- Chronic venous obstruction is commonly a late manifestation of DVT and can lead to severe post-thrombotic syndrome and venous ulceration. Endovascular recanalization with balloon angioplasty and stenting can relieve symptoms and promote ulcer healing.
- Open venous surgery in the form of thrombectomy for acute DVT and venous bypass for chronic venous obstruction is an effective treatment modality that is typically reserved for patients who fail endovascular therapy.

## INTRODUCTION

Deep vein thrombosis (DVT) is the third most common cause of cardiovascular morbidity with acute life-threatening complications, including pulmonary embolism and rarely limb-threatening complications such as phlegmasia cerulea dolens.<sup>1,2</sup> Chronic sequelae of DVT, popularly known as postthrombotic syndrome (PTS) occurs in 20% to 50% of the patients. PTS usually occurs within 2 years of onset of DVT despite anticoagulation and compression and is associated with significant morbidity and health care costs.<sup>3-5</sup>

Although traditional conservative measures such as anticoagulation and compression stockings remain the primary treatment of acute DVT, percutaneous endovascular surgical therapy can lead to rapid relief of symptoms with low complications and low subsequent incidence of PTS.<sup>6-9</sup> In

chronic DVT, endovenous recanalization and stenting of venous obstruction is an effective and durable treatment for patients with moderate to severe PTS. Open thrombectomy and venous bypass are traditional surgical options used in limb threatening conditions such as phlegmasia and in cases where endovascular interventions fail or are not possible. This article reviews the current options for treatment of DVT in the acute and chronic settings.

## ACUTE DEEP VEIN THROMBOSIS *Rationale for Thrombus Removal*

Early removal of thrombus can prevent a high sustained venous pressure, restore venous patency, and preserve valve function by limiting damage to venous valves, thus preserving the physiology of veins.<sup>7,10</sup> Studies have reported that poor

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thrombus clearance can lead to valve dysfunction and recurrent thrombosis and is associated with development of PTS.<sup>8,11</sup> This led to the “open vein hypothesis,” which has been used as the rationale of early thrombus removal using endovascular techniques.<sup>8,12,13</sup>

### **Catheter-Directed Thrombolysis**

#### **Indications**

Catheter-directed thrombolysis (CDT) for acute DVT is still controversial, despite its wide adoption, because of the lack of level I evidence. This dilemma is probably best illustrated by the guidelines of the American College of Chest Physicians that initially favored lysis for treatment of iliofemoral DVT in the 8th edition (2008) but subsequently changed to favor anticoagulation alone in the following editions.<sup>14,15</sup> The Society of Vascular Surgery, Society of Interventional Radiology, and American Heart Association favor CDT for acute iliofemoral DVT presenting within 2 weeks of onset of symptoms in patients who have good life expectancy and are at low risk for bleeding and complications.<sup>16–18</sup> The ATTRACT trial was completed recently and was designed to compare CDT with anticoagulation alone in patients with proximal DVT and help vascular specialists to identify patients who could benefit most from this therapy.<sup>12</sup> The results of the trial have just been released and will be reviewed separately.

The use of systemic thrombolysis for acute iliofemoral DVT has been abandoned because of the high rate of incomplete thrombolysis and bleeding complications associated with it.<sup>9</sup> CDT involves local delivery of thrombolytic agent directly into the thrombus, which minimizes the total amount of thrombolytic agent required, treatment time, and risk of bleeding. The indication for performing CDT can be emergent, urgent, or elective as described in [Table 1](#).<sup>19</sup>

#### **Technique**

The first step for performing CDT is to determine the access site in order to maximize the infusion of thrombolytic agents within the thrombus. An ultrasound-guided venous puncture is performed typically in the popliteal vein. Other access options include the common femoral vein, the internal jugular, or the posterior tibial vein. An angiogram is performed to assess the extent of the thrombus ([Fig. 1](#)). Using fluoroscopic guidance, a combination of a catheter and a wire are advanced through the vein to traverse all the thrombus. An attempt should be made to cross all of the thrombus and confirm the location of the vein free of clot with an angiogram. The angiographic catheter is then exchanged for a

**Table 1**  
**Indication for catheter-directed thrombolysis**

<b>Indication</b>	<b>Diagnosis</b>	<b>Treatment Goal</b>
Emergent	Phlegmasia cerulea dolens	Limb salvage
Urgent	Inferior vena cava thrombosis (risk of renal failure and Budd–Chiari syndrome)	Prevent pulmonary embolism, preserve visceral organ drainage, relieve pelvic congestion
Elective	Acute iliofemoral DVT, with moderate to severe symptoms Severe symptomatic acute femoropopliteal DVT worsening despite anticoagulation	Immediate symptom relief, prevent PTS

multiside-hole catheter with infusion length that ideally matches the length of the thrombosed segment of the vein. The thrombolytic agent is then delivered directly into the thrombus through the infusion catheter. The thrombolytic agent commonly used is recombinant tissue plasminogen activator at a dose of 1 mg/h. A venogram is performed 12 to 24 hours after initiation of lysis to assess the degree of thrombus and the response to lytic therapy ([Fig. 2](#)). After 24 to 48 hours of thrombolytic therapy, all acute thrombus in the vein should be dissolved. Frequently, stenotic lesions especially in the iliac veins are uncovered that contribute to stasis and to the occurrence of DVT. These lesions are commonly related to arterial compression of the veins at the iliac arterial bifurcations.<sup>20</sup> They usually respond poorly to balloon angioplasty alone and require stenting ([Fig. 3](#)). Iliac lesions can sometimes be very subtle to detect on plane angiography, and the introduction of intravascular ultrasound (IVUS) has become the standard of care and is the best method to uncover hidden lesions.<sup>21</sup>

#### **Adjunctive therapy**

Since the introduction of CDT, several devices and techniques have been developed to enhance and accelerate intravascular thrombus removal. In addition to treating stenotic lesions that potentially

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