Venous Thromboembolic Disease: The Use of the Aspiration Thrombectomy Device AngioVac

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Abstract

Keywords

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- ▶ interventional radiology

Central venous thrombosis is a complex problem, particularly in cases where the thrombus burden is large. Several interventional techniques and devices have been developed over the past 15 to 20 years to manage this entity, but the vast majority of them still need the concomitant use of thrombolytics to achieve an optimal result. AngioVac (AngioDynamics, Latham, NY) is the first aspiration thrombectomy device capable to remove a larger burden of undesired intravascular material such as thrombus, tumor, and foreign bodies without the need of lytics. This review focuses on the AngioVac device in the management of ilio caval thrombosis and pulmonary embolism.

Objectives: Upon completion of this article, the reader will be able to describe the AngioVac device, as well as the indications and contraindications for its use and limitations of the device.

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In the past two decades, several new techniques and tools for removal of large central venous thrombus have been introduced.^{1–5} Bleeding risk associated with prolonged infusion of thrombolytics agents and its limited effectiveness to treat subacute and chronic thrombus remain as significant challenges to achieve good clinical outcomes. This has prompted search for better methods for thrombus removal.

Catheter-based thrombus removal can be achieved by many means, as aspiration, fragmentation, extraction, or rheolytic thrombectomy. However, all these techniques may require concomitant use of thrombolytic therapy in the presence of a large burden of thrombus.

The AngioVac (AngioDynamics, Latham, NY) system has emerged as a thrombus aspiration tool indicated for removal of undesired intravascular material such as thrombus, tumor, and foreign bodies. This novel technology has been used successfully in the management of acute and subacute ilio-caval thrombosis,⁶ catheter-related central venous thrombus, atrial tumors/thrombus,^{7,8} valve vegetations,⁹ and submassive and massive pulmonary emboli.¹⁰

The AngioVac Aspiration Thrombectomy Device

The AngioVac system is manufactured by Vortex Medical for AngioDynamics, and is approved by The U.S. Food and Drug Administration (FDA) “to remove fresh, soft thrombi or emboli during extracorporeal bypass for up to 6 hours.”

The AngioVac system consists of a 22F suction cannula and is combined with a veno-venous bypass circuit and a reinfusion cannula.¹¹ While on bypass circuit, the blood passes

Fig. 1 Schematic representing the AngioVac system (AngioDynamics, Latham, NY) and its setup.

through a filter canister, which traps any undesired material such as thrombus, before being reinfused into the patient via a reinfusion cannula (►Fig. 1). The tip of the suction cannula is designed with an expandable funnel which is balloon-actuated or expandable to optimize and enhance the aspiration and engagement area for the aspiration material. The current design is available either with a straight or with a 20-degree angle tip, increasing the ability to steer the device (►Fig. 2). The cannula is usually inserted through a 26F

diameter by 28-cm long, DrySeal sheath (W.L. Gore & Associates, Flagstaff, AZ).

The extra-corporeal bypass circuit (AngioVac circuit) consists of an aspiration line, a filter, pump head, and a reinfusion line. The circuit can be used with off-the-shelf pump, filter, and reinfusion cannula (►Fig. 1).

The advantage of the AngioVac over other existing devices is the large bore aspiration cannula, which allows aspiration of large volumes of thrombus. To the authors' knowledge, it is the only available device capable of removing acute and subacute thrombus from large veins in one setting.⁶ It differs from the rheolytic devices such as AngioJet (Boston Scientific, Marlborough, MA) and Hydrolyser (Cordis Europa N.V., Roden, the Netherlands), which can cause significant hemolysis and arrhythmias. The AngioVac system aspirates blood, filters the blood, and then delivers it back to the circulation, causing no hemolysis.

Iliocaval Thrombosis

Primary ilio caval thrombosis is a rare entity with potential significant morbidity and mortality.¹² Although the real incidence of inferior vena cava (IVC) thrombosis is unknown, the rate has increased with the introduction of permanent or retrievable IVC filters.^{13,14} Only 10 to 20% of patients with

Fig. 2 AngioVac cannula tip (AngioDynamics, Latham, NY). (a) 20 degree angle tip which aids in navigation and allows some steerability. (b) Straight tip presentation.

deep vein thrombosis (DVT) will develop ilio caval segment thrombosis and less than 3% of the thrombosed iliac veins will progress to complete caval thrombosis.

IVC thrombosis related to filter placement is more common than primary occlusion. Recent CT-based follow-up study in patients who had IVC filters demonstrated an incidence of 18.6% of IVC thrombosis.¹³ IVC occlusion can lead to a significant morbidity with severe lower extremity swelling, pain, numbness, venous claudication, and chronic venous stasis skin changes.

Several techniques have been developed over the past 20 years to treat symptomatic ilio caval thrombosis. This includes pharmacomechanical thrombectomy and balloon angioplasty, with and without stenting. In patients with large thrombus burden and/or contraindications to thrombolytic therapy, the AngioVac device is an alternative which has become an important resource. Mechanical devices such as AngioJet (Boston Scientific), Arrow-Teratology (Arrow International, Inc., Reading, PA), Cleaner (Argon Medical, Plano, TX), and Trellis (Covidien, Mansfield, MA) are usually combined with thrombolytic therapy to get more complete thrombus removal. The AngioVac system appears to be capable of aspiration of large clot burden with little to no hemolysis, and minimal blood loss.

Donaldson et al¹⁵ described a single-center experience with 14 patients using the AngioVac system. Eleven patients (73%) had involvement of the IVC. In all of these 11 patients with IVC thrombosis, the authors reported a 100% success rate; they reported 79% overall success with all their procedures. The failures were felt to be related to extension of the thrombus beyond the reach of catheter in the pulmonary arteries because of the size of the catheter and inability to direct it adequately. The authors reported a drop in the hemoglobin levels in 11 of 15 patients, 6 of whom required blood transfusions.¹⁵

Smith et al reported three cases of successful use of AngioVac for ilio caval thrombosis with significant improvement in patient's symptoms and no procedure-associated mortality or complications.^{6,7}

Pulmonary Embolism

Approximately 200,000 patients die each year in the United States as a result of pulmonary embolism (PE). If the diagnosis is made in a timely fashion and therapy initiated, the mortality rate drops to 8%. Unfortunately, some of these patients cannot undergo conventional treatment such as thrombolysis due to elevated risk of bleeding. These patients are managed with anticoagulation and/or placement of an IVC filter. Surgical thrombectomy is an alternative, but it is a major operation and only available at larger medical centers. Current literature suggests that with use of modern endovascular techniques, central thrombus debulking should be considered immediately for patients with severe symptoms and clinical findings.

The AngioVac system is a promising alternative to surgical thromboembolism and even thrombolysis in the case of pulmonary emboli. Few reports are published on pulmonary

artery thrombus aspiration using the AngioVac system. Donaldson et al¹⁵ reported on five patients with pulmonary emboli in their material, but specific outcomes from the procedure are not easily obtained from the study.

Pasha et al published a single case of pulmonary emboli aspiration using the AngioVac system.¹⁰

One concern with this device, particularly with regard to the treatment of pulmonary emboli, is that it is difficult to get the AngioVac system into the pulmonary artery because of its size and lack of flexibility and steerability.

The Procedure

AngioVac procedures are performed under general anesthesia. Both sides of the neck and both groins should be prepped for possible access. All venous punctures should be made under ultrasound guidance. The patient is then fully anticoagulated with heparin reaching an activated clotting time in longer than 300 seconds.

A closed AngioVac bypass circuit is created on the table. This allows priming and removing all possible air bubbles from all lines, filter, and the bypass pump. In the meantime, the reinfusion cannula is inserted (►Fig. 1). The right internal jugular vein is the preferred access for cases of IVC thrombosis and pulmonary artery thrombosis, but common femoral vein access is preferred in patients with superior vena cava thrombus and thrombus on central venous catheters. The infusion cannula is placed in an internal jugular vein or common femoral vein which is not used for the AngioVac and where there is no thrombus. The 26F DrySeal sheath is inserted over a stiff guide wire and under fluoroscopic guidance. Through this sheath, the 22F AngioVac cannula is placed over the wire.

The AngioVac catheter is slowly advanced against the thrombus, and moved to and fro until the thrombus is aspirated.

Special attention is needed when the cannula is advanced across IVC filters as the cannula can engage the filters and cause mangling or even displacement of the filter.

Crossing the tricuspid valve requires caution. This can be achieved with the use of a pigtail catheter first to help with a central valvular crossing to avoid damage to the chordae tendineae.

With the current iteration of the system, pulmonary embolism aspiration should probably be performed only in severe cases. The company recommends use of extracorporeal membrane oxygenation during the procedure for pulmonary emboli.

At the end of the procedure, the aspiration cannula and the introducer are removed. The vascular access can be closed using a purse-string suture, direct suture repair, or manual compression for 20 to 30 minutes.

For AngioVac aspiration in the chest, transesophageal ultrasound can be of great help to guide engagement of the catheter with the thrombus. In the IVC, especially the lower portion, the transesophageal ultrasound will not have enough length. In those cases, one has to rely on intermittent venography and fluoroscopy (►Fig. 3). It is also possible to use

Fig. 3 Representative case of a patient with significant inferior vena cava (IVC) thrombosis. (a) Venography of the IVC preintervention demonstrates severe IVC thrombosis (arrow); the AngioVac device is in position for aspiration of the clot (arrowhead). (b) Venography demonstrates near-complete removal of the occlusive clot. The AngioVac device (AngioDynamics, Latham, NY) is again noted (arrowhead).

intravascular ultrasound and intracardiac ultrasound (Acuson AcuNav ultrasound catheter system; Acuson Corporation, Mountain View, CA) for direction of the aspiration.

Conclusion

The AngioVac system is an interesting and promising tool for removal of large volumes of thrombus. It has the potential to replace open cardiopulmonary surgery for thromboembolic disease affecting the pulmonary arteries, central line associated thrombus, and cardiac vegetations and tumors. It is effective at aspirating large volumes of acute and subacute thrombus in larger veins such as the IVC and iliac veins.

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