Endovascular Thrombus Aspiration Using the AngioVac System. Technical Considerations and Operating Room Setup

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Abstract:

Purpose: The AngioVac system has been suggested as an effective addition to the surgeon's armamentarium for the management of patients with inferior vena cava thrombosis, pulmonary embolism, as well as tricuspid valve endocarditis. It offers a minimally invasive endovascular approach using an extracorporeal veno-venous bypass circuit equipped with a thrombus-capturing filter. We aim to describe the perioperative technical considerations associated with the use of AngioVac system.

Technique: Under general anesthesia and thransesophageal echocardiographic (TEE) guidance, the AngioVac system utilizes a funnel-shaped inflow cannula and an extracorporeal circulation (ECC) bypass circuit for endovascular thrombus aspiration. A centrifugal pump circulates blood through the AngioVac circuit and thrombi are captured by a dedicated filter attached to the circuit.

Conclusion: Endovascular thrombus aspiration using this minimally invasive technique demonstrates an attractive alternative in inferior vena cava and cavo-atrial thrombosis. Its efficient nature makes it an invaluable tool for use by a multidisciplinary team of physicians.

Keywords: AngioVac, thrombus aspiration, how to do it

INTRODUCTION

Endovascular vacuum-assisted thrombectomy using the AngioVac cannula (AngioDynamics, Latham, NY) has increasingly been used in the treatment of inferior vena cava (IVC) thrombosis after receiving Food and Drug Administration (FDA) and European Union CE mark approval in 2009 and 2013, respectively.[1] Its successful use in conditions involving the IVC led to an expansion in its indications. The AngioVac system has now been used for the endovascular management of a variety of thrombotic conditions such as tricuspid valve endocarditis for the aspiration of valve vegetations, aspiration of large pulmonary emboli from the pulmonary artery and its main branches and, most recently, in tumor-thrombus removal from the IVC and/or right atrium in high surgical risk patients with renal cell carcinoma and cavo-atrial extension.[2-5]

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Successful AngioVac use prerequisites adequate technical knowledge of the device as well as excellent cooperation among physicians and other healthcare professionals from multiple different disciplines such as cardiothoracic surgery, vascular surgery, anaesthesiology, cardiology, interventional radiology, perfusionist, and others. The present paper aims to briefly delineate important technical aspects in the use of the AngioVac system for IVC thrombosis.

THE ANGIOVAC SYSTEM

The third generation AngioVac system includes an inflow cannula and a circuit for assembly with the extracorporeal circulation (ECC). The funnel-shaped 22Fr cannula is available with either a 20° or 180° angled tip (Figure 1). The slide-over-sheath fashion of the self-expanding funnel shaped cannula enables easy manipulation by the operator for desired angulations (Figure 2). When enabled, a proximal locking mechanism prevents accidental sliding of the cannula over the sheath. A Y-adapter equipped with a working side port located in the proximal portion of the cannula allows for guidewire insertion and over-the-wire cannula guidance. The side port can be also used for insertion of endovascular snaring devices which can be useful in persistent thrombi. The AngioVac circuit is composed of 3/8" tubing system which is connected to the ECC unit by standard fashion and is equipped with a thrombus-capturing filter. Importantly, the manufacturer provides neither an introducer sheath nor a reinfusion cannula

for venous blood return. Although not mandatory, we have found that an introducer sheath such as the GORE® DrySeal Flex Introducer Sheath 26Fr provides a steady platform for cannula manipulation. We have found that the DrySeal valve enables introduction of the AngioVac device with great haemostasis and control and we highly recommend it against other similar introducer sheaths. A reinfusion cannula of 20Fr such as the EOPA® (Medtronic, Minneapolis, MN) cannula can be used for venous return. A standard ECC unit equipped with a single centrifugal pump is necessary, without the need for an oxygenator or reservoir. Table 1 summarizes the necessary AngioVac equipment.

Guidewires, sheaths & catheters	5 Fr. Introducer sheath Lunderquist® Extra-Stiff guidewire (Cook Medical Inc.), 260cm, 0.035” 5 Fr. Standard Angiographic Catheter GORE® DrySeal Flex Introducer Sheath 26 Fr.
Cannulae	Inflow 22Fr cannula angled 20° or 180° Reinflow cannula for venous return (e.g. EOPA® 20 Fr.)
Extracorporeal circulation	Centrifugal pump Pump controller ECC circuit (3/8” tubing) Thrombus filter

Table 1. AngioVac system material checklist.

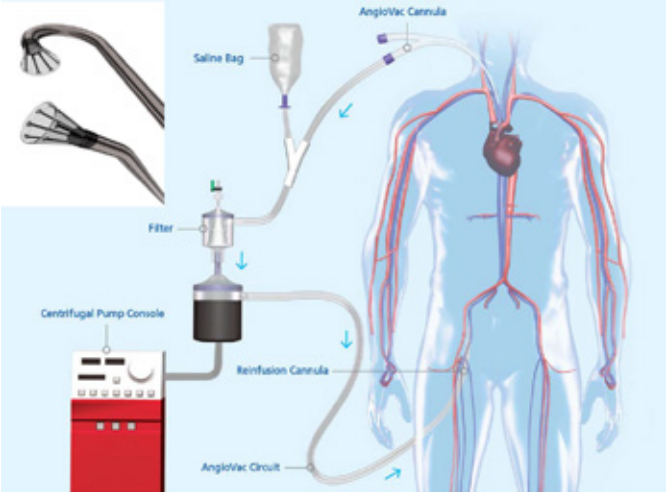

Figure 1. The AngioVac system and its associated 20° and 180° funnel-shaped cannulae. Arrows indicate the flow of blood from the inflow AngioVac cannula in the IJV through the thrombus filter, centrifugal pump and AngioVac circuit to venous return via femoral vein. Reproduced with permission from AngioDynamics.

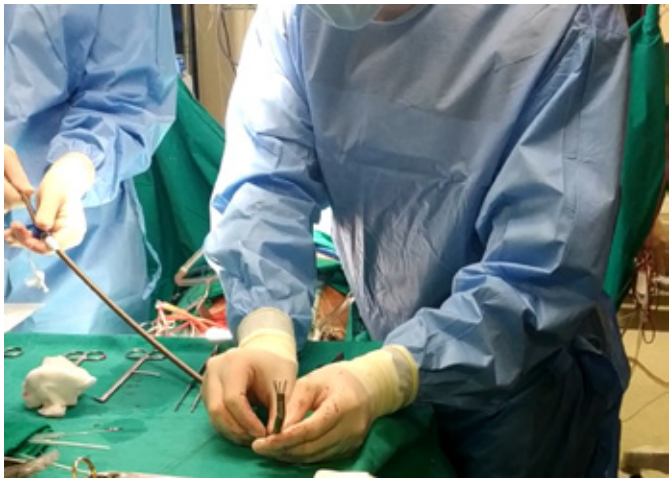

Figure 2. The AngioVac 180° cannula manipulated into different angulations.

Indications

The AngioVac system is intended for aspiration of fresh, soft thrombi and emboli by means of venous drainage and extracorporeal bypass. Pacemaker lead and tricuspid valve vegetations due to endocarditis, right atrial thrombus removal, iliofemoral and IVC thrombosis as well as deep vein thrombosis (DVT) thrombus in transit are the main indications for use.

Contraindications

According to the manufacturer, severe arterial or venous vascular disease, use for chronic adherent intravascular material (chronic pulmonary embolism, atherosclerotic plaques) are among the device’s contraindications. Device use is also contraindicated for use during active cardiopulmonary resuscitation.

PREOPERATIVE CONSIDERATIONS

Careful preoperative patient evaluation is of outmost importance. Computed tomography angiography is used for assessment of thrombus extension. When the supradiaphragmatic segment of IVC is involved, further cardiac evaluation with both transthoracic (TTE) and transoesophageal (TEE) echocardiography is performed. Operation planning is suited to each patient’s characteristics. The inflow cannula can be inserted at either the femoral vein or the internal jugular vein (IJV). For IVC thrombus, positioning of the funnel-shaped cannula at the IVC-right atrial junction might prevent emboli escaping to the pulmonary circulation by continuous suction. We have found the following manoeuvre particularly useful and practical; when planning to introduce the inflow cannula through the IJV, a percutaneous over-the-wire standard angi-

ographic catheter can be positioned up to the IJV, through a 5-Fr sheath placed in the left femoral vein, under fluoroscopic guidance. This allows for retrograde introduction of a Lunderquist® Extra-Stiff guidewire (Cook Medical Inc.) from the IJV to femoral vein during the operation and over-the-wire guidance of the inflow cannula to the IVC-right atrial junction.

TECHNIQUE

The operation takes place in the operating room under TEE or in a hybrid operating theatre under both fluoroscopic and TEE guidance. After general anaesthesia, the TEE probe is introduced to obtain a bi-caval view for visualisation of superior vena cava (SVC), right atrium, and IVC. The right IJV and right femoral vein are exposed, and a purse string with 5-0 polypropylene suture is placed. Systemic heparinization is achieved and maintained with an active clotting time of >250sec. The IJV is incised to gain access to the angiographic catheter (Figure 3), which was previously placed from the left femoral vein.

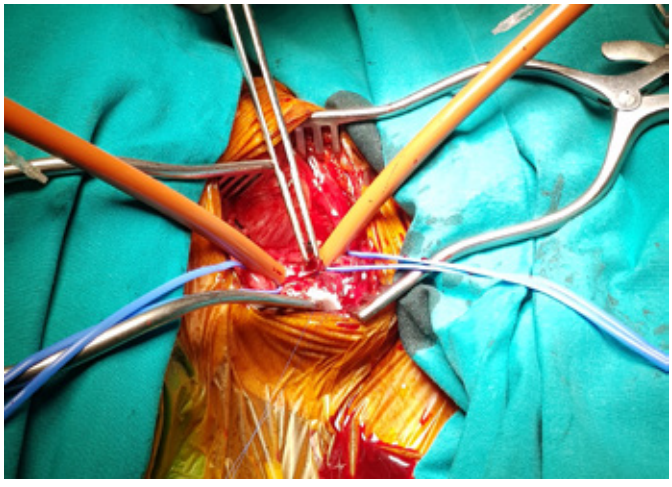

Figure 3. The right internal jugular vein is incised and the angiographic catheter is captured by the forceps.

While the assisting surgeon holds the catheter, the operating surgeon introduces the Lunderquist® Extra-Stiff guidewire which exits through the left femoral vein. After catheter removal through the left femoral vein, the introducer sheath is inserted over-the-wire in the IJV and left in place. The reinfusion cannula is inserted in the right femoral vein. The AngioVac cannula is introduced through the sheath in the IJV in an over-the-wire fashion, and after careful and meticulous de-airing, the primed circuit is connected to both cannulae. Under continuous TEE guidance, the funnel-shaped cannula tip is positioned in the IVC-right atrial junction. After making sure that the locking mechanism is secured at the desired cannula angulation, veno-venous bypass is initiated with the centrifugal pump generating flow rates of up to 3.5l/min (2500 - 3500 rpm). The device operating time is defined according to individual patient needs. After ECC termination, the cannulae are removed and the vessels are secured using the purse string suture. Figure 4A illustrates the IVC thrombus as seen with the TEE before AngioVac treatment. Note the thrombus removal after AngioVac therapy (Figure 4B). The circuit filter is then inspected for thrombi which are in turn admitted for microbiological and histological evaluation (Figure 5).

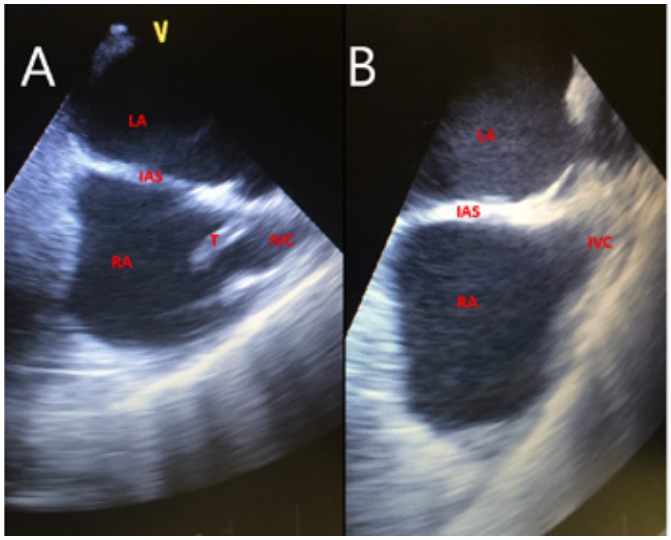

Figure 4. Transesophageal echocardiography (TEE) demonstrating the IVC thrombus before (A) and after (B) AngioVac therapy. RA; right atrium, LA; left atrium, IAS; interatrial septum, IVC; inferior vena cava, T; thrombus

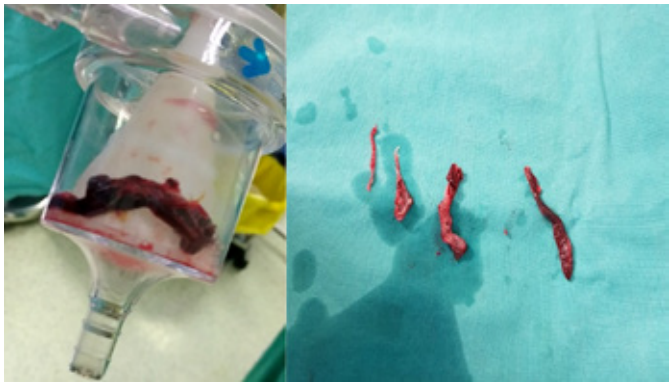

Figure 5. Inferior vena cava thrombi captured by the filter.

DISCUSSION

Thrombi aspiration using the endovascular approach offered with the AngioVac system can be done relatively simply and safely. Special caution must be paid during vessel manipulation to avoid vessel injury. Although we prefer a cut-down technique for complete vessel exposure and vascular control, the AngioVac cannulae can be introduced percutaneously.[1] Various percutaneous closure techniques are available, ranging from traditional vessel pressure application and thick nylon sutures, to more modern perclose vascular closure devices such are the MANTA®, ANGIO-SEAL® VIP, and ProGlide™ SMC System. TEE is necessary in guiding the cannula during the operation as well as providing cardiac evaluation postoperatively to ensure that the right-sided cardiac chambers and pulmonary arteries are free from potential emboli. Alternative surgical treatments of IVC thrombosis with atrial extension involve surgical embolectomy which often requires total circulatory

arrest and carry increased mortality rates.[1] Excellent AngioVac results are presented in the recently published Registry of AngioVac Procedures in Detail (RAPID) prospective multicenter trial which studied the device's effectiveness in removal of thrombi and right heart masses in 234 patients.[5] A meta-analysis of 42 studies identified a total of 182 patients who were treated with the AngioVac system for either endocardial vegetation or thrombosis.[4] Other endovascular thrombus - aspirating devices such as the Indigo Mechanical Thrombectomy System (Penumbra, Inc., Alameda, CA) and Inari FlowTriever® (Inari Medical, Irvine, CA), which do not require the use of an ECC unit are available to market.[6, 7] Our experience with the AngioVac system confirms that it is a safe and effective mode of thrombus aspiration..

CONCLUSION

The minimally invasive nature of AngioVac system makes it an invaluable tool for the management of complex thrombotic conditions such as iliocaval and cavo-atrial thrombosis, pulmonary embolism, and right sided endocarditis.

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Conflict of interest: None

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