Successful cerebral protection during removal of large right atrial thrombus with AngioVac in a patient with patent foramen ovale and recent embolic stroke

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ABSTRACT

Complications associated with central venous catheterization include deep venous thrombosis and atrial thrombi, among others. Large thrombi, including intracardiac thrombi, have classically been managed medically or with open surgery. However, recent reports detail the utility of the AngioVac system (AngioDynamics, Latham, NY), a vacuum-assisted suction thrombectomy system using a venous-venous extracorporeal circuit. Here, we present the case of a critically ill woman with large right atrial thrombus, patent foramen ovale, and recent embolic stroke who underwent successful vacuum-assisted suction thrombectomy with use of the Sentinel Cerebral Protection System (Boston Scientific, Marlborough, Mass) for stroke prevention. (J Vasc Surg Cases and Innovative Techniques 2019;5:201-4.)

Keywords: Cerebral protection; Atrial thrombus; AngioVac system; Patent foramen ovale

In the United States, >5 million catheters are inserted for various indications yearly,[1] with autopsy studies demonstrating increased risk of venous thrombosis in cannulated vs noncannulated veins (36% vs 1.6%, respectively).[2,3] Large thrombi, including intracardiac thrombi, have historically been managed medically or with open surgery. However, recent studies have demonstrated the utility of the AngioVac thrombectomy system (AngioDynamics, Latham, NY) in the management of select patients.[4,5] Here, we present the case of a critically ill woman with large right atrial thrombus, patent foramen ovale (PFO), and recent embolic stroke. The patient's consent was obtained for publication of this report.

CASE REPORT

The patient is a 27-year-old woman with a history of anorexia nervosa requiring long-term central venous access for total parenteral nutrition. She also had gastroparesis, heart failure with reduced ejection fraction, prolonged QT interval, history of cardiac arrest status post automatic implantable cardioverter-defibrillator, and recurrent methicillin-sensitive *Staphylococcus aureus* (MSSA) bacteremia. She initially presented with left middle cerebral artery stroke resulting in expressive aphasia and right upper (1/5 strength) and lower (3/5 strength) extremity weakness, believed to be of embolic origin. Transthoracic echocardiography revealed a 2.0- ×1.4-cm right atrial mass consistent with central line-associated thrombus (Fig 1, *A*), which was also demonstrated on contrast-enhanced computed tomography (Fig 1, *B*). Echocardiography further revealed a PFO, with closure of the PFO considered by the cardiology service. However, given the MSSA bacteremia, it was contraindicated because of the infection risk. The patient's central line was removed, and she was prescribed therapeutic anticoagulation and intravenous nafcillin 1.5 g every 6 hours for recurrent MSSA bacteremia. However, the thrombus continued to increase in size despite adequate levels of anticoagulation with heparin drip measured by partial thromboplastin time of 60 to 90 seconds; on follow-up echocardiography 1 week later, it measured 2.6- ×1.6-cm (Fig 2). The vascular surgery service was consulted, with open vs percutaneous suction thrombectomy considered. Given the patient's PFO and recent embolic stroke with concern for possibility of further embolization, the decision was made to employ the Sentinel Cerebral Protection System (CPS; Boston Scientific, Marlborough, Mass), the only commercially available device able to filter, capture, and remove debris during endovascular procedures to help prevent stroke and protect the patient's carotid arteries from further embolization during vacuum-assisted suction thrombectomy with the AngioVac system in the setting of a PFO.

The patient was brought to the operating room, with sterile preparation of her right upper extremity, bilateral neck, chest, abdomen, and groins performed. The right brachial artery was exposed in an open fashion, followed by introduction of the Sentinel CPS with the proximal filter deployed in the innominate artery (Fig 3, *A*), followed by shaping of the catheter tip (Fig 3, *B*) and deployment of the distal filter within the left common carotid artery (Fig 3, *C*) per instructions for use after systemic heparinization. Attention was then turned to obtaining ultrasound-guided venous access; two sheaths were placed in the right common femoral vein, one 7F for snare placement

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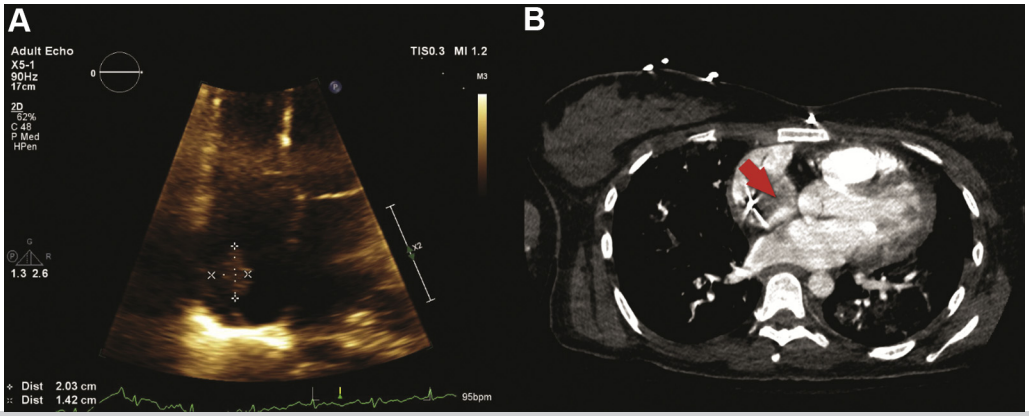

Fig 1. A, Initial transthoracic echocardiogram demonstrating 2.03- ×1.42-cm right atrial mass. **B,** Computed tomography angiogram of the chest demonstrating right atrial mass (*arrow*).

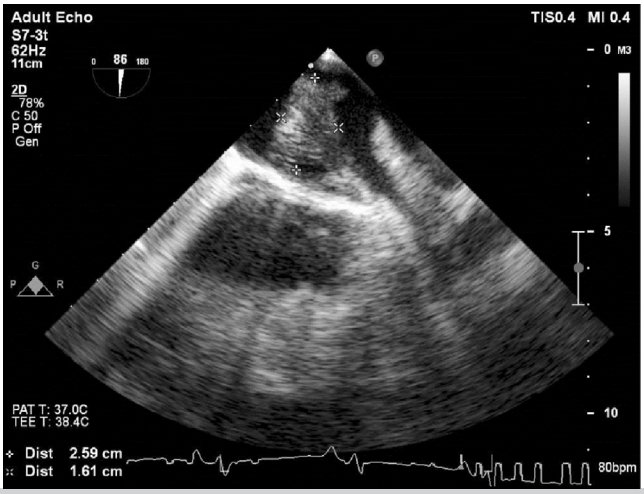

Fig 2. Transthoracic echocardiogram on hospital day 8 demonstrating 2.59- ×1.61-cm right atrial mass.

and the other serially dilated with placement of a 26F DrySeal (Gore Medical, Flagstaff, Ariz) sheath. Ultrasound-guided access was also obtained in the right common femoral artery. A 17F sheath was placed in the left common femoral vein for the return cannula. The snare was placed around the 26F sheath, with the AngioVac cannula then advanced through the larger sheath into the inferior vena cava; the snare was placed below the balloon for manipulation of the cannula, after which the balloon was deployed and the AngioVac cannula was advanced under suction at 3 L/min. To change the direction of the cannula tip at its distal end with the snare, downward traction is applied to the snare while the cannula is advanced forward, which causes the distal end of the cannula to bend and to change direction. The snare acts as a point of countertraction against the forward advancement of the cannula, with the tip of the balloon-tipped cannula remaining relatively stationary in a craniocaudal direction but allowing the tip to be redirected in a lateral direction at this level.

Under transesophageal echocardiography (TEE) guidance, the cannula was advanced into the right atrium to suction the mass for 20 minutes and then withdrawn (Fig 4, *A*). TEE demonstrated that the mass had decreased from 2.6 × 1.6 cm to 1.5 × 1.5 cm. The cannula was then repositioned with assistance of the snare and further suction thrombectomy applied for 30 minutes, with a roughly 1- ×1-cm mass remaining. Given the location of the mass, the decision was made to approach the mass directly from a right internal jugular approach; a 26F sheath was placed, followed by introduction of the cannula into the right atrium under TEE guidance (Fig 4, *B*). After 25 minutes of additional suction thrombectomy, TEE demonstrated nearly complete resolution of the mass (Fig 5), noted to be 0.8 cm in maximum diameter and tightly adherent to the right atrial wall. Suction thrombectomy was terminated; all sheaths were removed, remaining blood was returned from the system, and puncture sites were approximated with suture and pressure held to obtain hemostasis. Attention was then turned to removal of the Sentinel CPS; the filters were inspected without evidence of particulate matter, and the brachial artery was closed with polypropylene suture, followed by closure of the skin in layers. Total case duration was 3 hours, with estimated blood loss of 300 mL. The patient's pulses were intact in all extremities; she awoke with her baseline neurologic examination and was transferred to the intensive care unit in stable condition. Neurologic examinations were performed before and after the procedure by the stroke neurology service; stable findings were noted on postoperative examination. Postoperative day 1 transthoracic echocardiography confirmed nearly complete resolution of the right atrial mass, and the patient was discharged home on therapeutic subcutaneous enoxaparin injections for anticoagulation on postoperative day 17, mainly because of placement issues and comorbidities, without further complication from right atrial thrombus. Cardiac magnetic resonance imaging at 3 months postoperatively revealed no evidence of clot recurrence.

DISCUSSION

The management of symptomatic right atrial thrombus in the setting of recent embolic stroke, MSSA bacteremia, and patent PFO is complex, given the risk of possible further embolization.

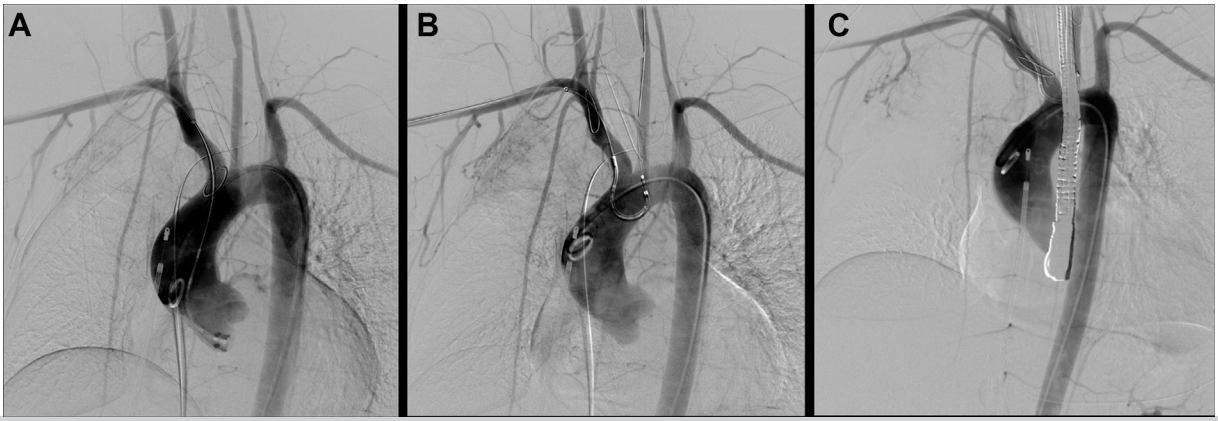

Fig 3. Angiogram demonstrating placement of the Sentinel Cerebral Protection System (CPS; Boston Scientific, Marlborough, Mass) with the proximal stent in the innominate artery **(A)**, shaping of the catheter tip and selection of the left common carotid artery **(B)**, and deployment of the distal filter in the left common carotid artery **(C)**.

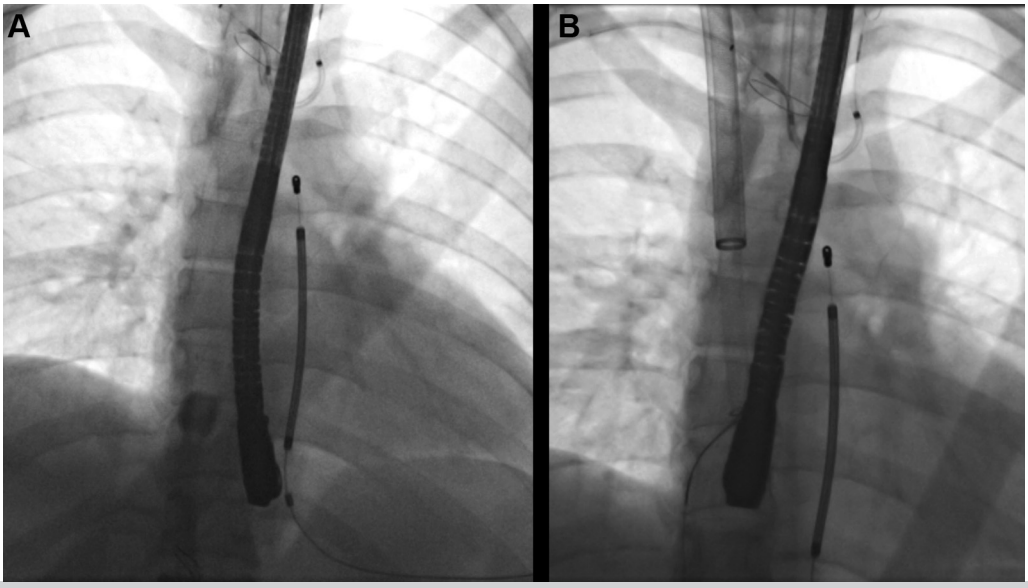

Fig 4. Fluoroscopy images demonstrating both the transfemoral approach **(A)** and the transjugular approach **(B)** with the AngioVac cannula noted in the right atrium with transesophageal echocardiography (TEE) probe for guidance.

This case demonstrates successful management of a large symptomatic right atrial thrombus with vacuum-assisted suction thrombectomy (AngioVac system) and concomitant use of the Sentinel CPS for prevention of further embolization and resultant stroke during suction thrombectomy. The Sentinel CPS is the only Food and Drug Administration (FDA)-cleared device for cerebral protection commercially available at this time, initially developed to reduce risk of stroke during transcatheter aortic valve replacement (TAVR).[6] The Sentinel CPS comes in one size and is appropriate for brachiocephalic artery diameters of 9 to 15 mm and left common carotid artery diameters of 6.5 to 10 mm.

The Sentinel CPS was initially cleared by the FDA in 2017, with promising results noted in several studies with use during TAVR.[7-9] These promising results during TAVR served as the basis for our rationale to use the Sentinel CPS in this patient's care, given the known risk of paradoxical embolization during suction thrombectomy of the right atrial mass. The AngioVac system, on the other hand, was approved by the FDA in 2009 for the removal of thrombi and emboli using a venous-venous extracorporeal bypass circuit. There have been several reports of successful use of the device in the management of patients with large-volume clot burden, those who have failed to respond to other endovascular intervention, and those with contraindications to thrombolysis.[5,10]

This case represents a complex patient with contraindication to thrombolysis, given recent left middle cerebral

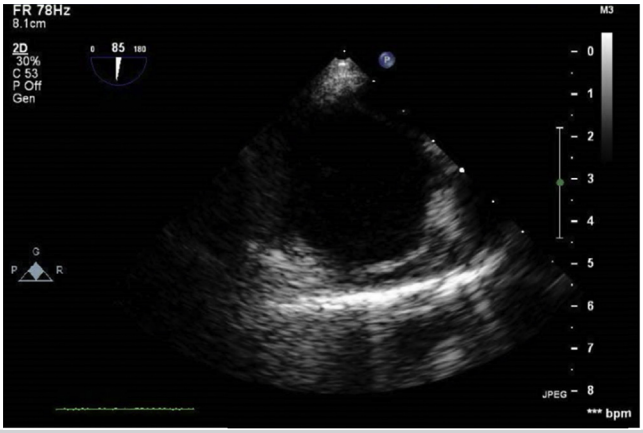

Fig 5. Completion intraoperative transesophageal echocardiography (TEE) demonstrating nearly complete resolution of the right atrial mass after suction thrombectomy with the AngioVac system.

artery stroke as well as presence of PFO, placing the patient at risk of further paradoxical embolization with resultant ischemia, including possible stroke. Whereas the idea of vacuum-assisted suction thrombectomy with the AngioVac system for removal of a large right atrial thrombus is not new, to our knowledge, this is the first report of successful removal of right atrial thrombus in the setting of PFO with use of a cerebral protection device. The case also demonstrates a new adjunctive technique in the management of right atrial thrombus with the AngioVac system in the setting on PFO to prevent paradoxical embolus. This adjunct can be performed with minimal increase in operating time and offers a reasonable stroke prevention strategy in those with PFO who are undergoing vacuum-assisted suction thrombectomy.

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