

First-in-paediatric uses of a mechanical aspiration system for percutaneous removal of right atrial masses

Brief Report

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Abstract

We present the first-in-paediatric uses of a mechanical aspiration system for percutaneous removal of right atrial masses in three patients, including central line-related thrombus and metastatic tumour. Percutaneous mechanical removal of right atrial masses can be performed safely and effectively.

Right atrial thrombus, although rare, is a cause of significant morbidity and mortality. While there is a paucity of paediatric data, right heart thrombi in adults are associated with an 80–100% mortality, mainly due to risk of pulmonary embolism.¹ In children, over 90% of right atrial thrombus cases are associated with central venous catheters.² For decades, management primarily relied on systemic anticoagulation, thrombolytic therapy, or surgical thrombectomy. When compared to no treatment, medical therapy has a high failure rate of approximately 30%.³ Methods of catheter-directed mechanical thrombectomy have recently been introduced and proven to be effective alternatives in adults. In particular, vacuum-assisted thrombectomy in adults has a procedural success rate of nearly 80% for right atrial and ilio caval thrombi.⁴ This report describes the first uses of the AlphaVac (AngioDynamics, Latham, NY) mechanical aspiration device for percutaneous removal of right atrial masses in three paediatric patients in the congenital cardiac catheterisation laboratory.

Case #1

A 14-year-old male suffered an abdominal gunshot wound and required long-term central line access at an outside institution. His course was complicated by gastrointestinal bleeds, central line-associated infections, and pulmonary embolism. A transoesophageal echocardiogram showed a large, highly mobile right atrial mass measuring 2.1×1.2 cm (Fig 1a) with a chest CT negative for pulmonary embolism at that time. His central line was removed. He did not tolerate systemic anticoagulation due to ongoing gastrointestinal bleeding and was a poor surgical thrombectomy candidate due to poor wound healing. Therefore, the decision was made to perform percutaneous mechanical thrombectomy.

Under general anaesthesia, a 22-French 33 cm long Gore DrySeal sheath (WL Gore & Associates, Flagstaff, AZ) was placed in the right internal jugular vein with the tip at the superior caval vein-right atrial junction. The AlphaVac system's delivery sheath was inserted coaxially, followed by advancement of the AlphaVac F18⁸⁵ system, which was used to engage the mass with echocardiographic guidance (Fig 2). Multiple aspirations were performed and the entire mass was removed (Fig 1b-d), later proven to be thrombus on pathology. The patient was haemodynamically stable throughout the case with 200 ml blood loss and no significant change in haemoglobin or potassium.

Case #2

An 18-year-old male with desmoplastic small round cell tumour was found to have a new right atrial thrombus measuring $3.2 \times 2.5 \times 2.0$ cm three months following chemotherapy port placement. This thrombus was refractory to 7 weeks of enoxaparin therapy. During the procedure, a 22-French 33 cm long Gore DrySeal sheath was placed in the right internal jugular vein with the tip at the superior vena cava-right atrial junction. The AlphaVac F18⁸⁵ system was advanced through the AlphaVac delivery sheath and multiple aspirations resulted in complete thrombus removal. Blood loss was 180 ml and, due to baseline anaemia, a blood transfusion was given.

Case #3

A 15-year-old male with the history of left proximal tibial osteosarcoma status-post limb salvage surgery was found to have a large, calcified right atrial mass by echocardiogram 4 months after

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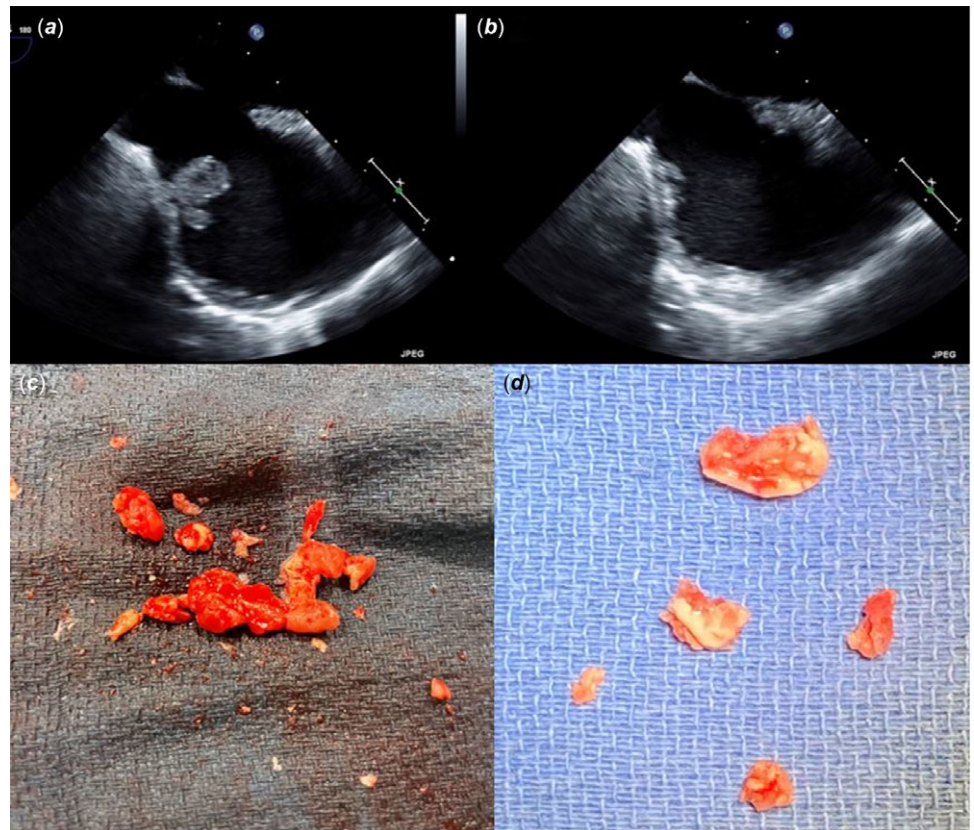


Figure 1. (a and b) Transoesophageal echocardiogram (TEE) images before and after thrombus removal in Case 1 with no residual thrombus. (c) Removed thrombus from Case 1, (d) removed tumour from Case 3.

chemotherapy port placement. Despite 10 months of treatment with enoxaparin and rivaroxaban, serial echocardiograms showed a stable, 1.2×1.5 cm mass attached to the inferior right atrial free wall. An agitated saline echocardiogram revealed a trivial right-to-left shunt with Valsalva manoeuvre. Given the persistence of the mass in the setting of an induced right-to-left shunt, he was referred for mass removal.

The presence of a large, mobile, calcified mass measuring 1.6×0.9 cm in the right atrium was confirmed by transoesophageal echocardiogram. The larger AlphaVac F22¹⁸⁰ system was utilised, which required a 26-French 33 cm long Gore DrySeal sheath in the right internal jugular vein, and a femoral vein was accessed to facilitate occlusion of the atrial communication with a 6-French balloon-tipped catheter to protect against paradoxical emboli. After several aspirations, only a small residual calcification remained adherent along the right atrial wall. Pathology showed the mass to be consistent with a metastatic tumour with extensive treatment effect, explaining the minimal response to anticoagulation.

Discussion/Conclusion

In previously reported cases of paediatric right atrial masses, treatment consisted of either surgical resection or anticoagulation.⁵⁻⁷ In 2015, Khan and Momenah reported the percutaneous removal of a ventriculoatrial shunt-associated right atrial thrombus in a 12-year-old using negative pressure from a 20 cc syringe.⁸ Aspiration-based systems for vacuum-assisted thrombectomy of intracardiac masses in adults have attenuated the risk of haemolysis and bradyarrhythmia seen with the rheolytic devices,⁴ but there is a paucity of paediatric data.^{8,9}

This case series describes the use of a novel percutaneous mechanical aspiration system to remove right atrial masses in three patients, including the first paediatric uses of this particular system for both thrombectomy and removal of a calcified metastatic tumour. Notably, we were able to successfully remove the mass in all three cases regardless of the chronicity of the mass, which spanned from acute (<2 weeks) to subacute (6–8 weeks) and chronic (>6 months).

The unique aspects of AlphaVac system include a braided shaft with a catheter angulation of 85° in the F18⁸⁵ and 180° and 20° in the F22¹⁸⁰ and F22²⁰ systems, respectively (Fig 2c). This catheter angulation can be lessened by retracting the catheter into the delivery sheath. The F18 system does have its own haemostatic valve, but can be introduced through a 22-French Gore DrySeal sheath, and the F22 system through a 26-French Gore DrySeal sheath. The nitinol-reinforced, self-expanding, soft funnel at the catheter tip is unique to this system, engages the thrombus for aspiration (Fig 2c), applies a relatively atraumatic material in contact with atrial tissue, and is easily seen both fluoroscopically and by transoesophageal echocardiography. Echocardiography was essential to choosing the point of vascular access and guiding the catheter angle and direction towards the mass in our cases. The funnel opening diameter is 11 mm and 14 mm in the F18 and F22 systems, respectively. The handle of the system has a volume-limiting switch for each aspiration (10 or 30 cc) of blood/thrombus (Fig 2d). With each aspiration, the handle has a vacuum-locking mechanism to maintain negative pressure, allowing the interventionalist to remove the mass in a controlled fashion.

Percutaneous mechanical removal of right atrial masses is feasible, safe, and effective and can be expanded beyond acute thrombus to chronic and nonthrombotic masses that fail medical

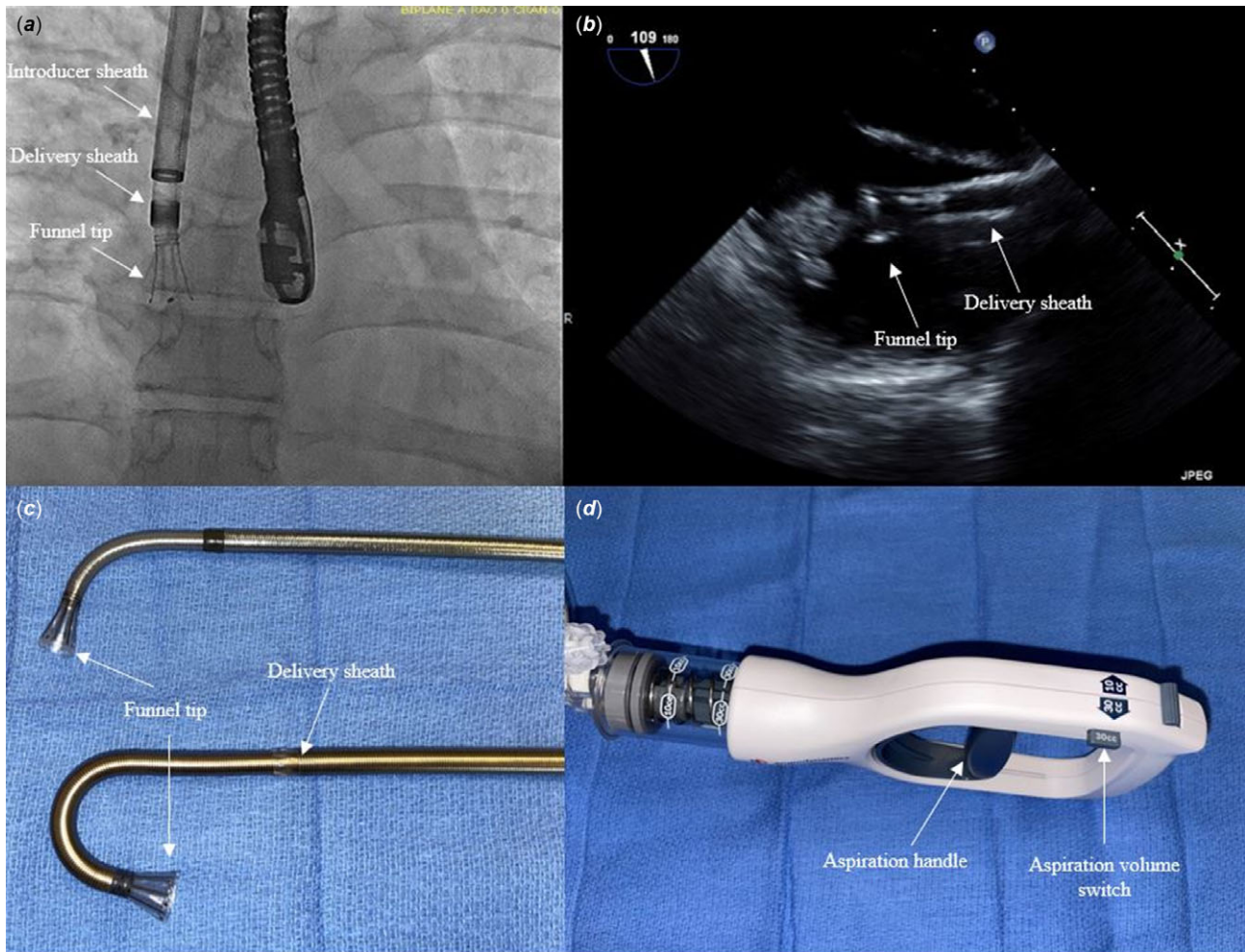


Figure 2. (a) Fluoroscopy of AlphaVac F18⁸⁵ system through the delivery sheath, coaxially through the 22Fr Gore DrySeal sheath positioned in the right atrium with transoesophageal echocardiogram (TEE) guidance. (b) TEE still image showing the AlphaVac funnel tip engaging thrombus. (c) F18⁸⁵ and F22¹⁸⁰ AlphaVac catheters with curved tips fully deployed through their delivery sheaths. (d) Aspiration handle with 10cc and 30cc aspiration volume settings.

treatment or are present in patients with contraindications to medical treatment. This option can easily be implemented in the congenital cardiac catheterisation laboratory.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/S1047951123000318>

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Conflicts of interest. None.

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