

## CASE REPORT

# Evacuation of a Large Intracardiac Thrombus at Cavoatrial Junction Using a Coaxial Aspiration System Through an ÖNÖ Retrieval Device in a Pediatric Patient

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## ABSTRACT

Intracardiac thrombus in the right heart has a great risk of embolizing to the pulmonary circulation leading to great morbidity and mortality. Removal of large thrombi incurs an increased risk of embolization, especially if the clot is more acute and not fully adherent. We present a case of transcatheter removal of a thrombus at the right atrial and superior vena cava (RA-SVC) junction using a novel technique in a patient with transfusion-dependent Fanconi anemia status, bone marrow transplant, and steroid-resistant graft-versus-host disease using a coaxial system of a Penumbra Thrombectomy catheter with a ÖNÖ Retrieval Device. Systemic anticoagulation or thrombolysis may be ineffective in treating large and organized thrombi, and most surgical management techniques require cardiopulmonary bypass in these often fragile patients. The combined use of multiple intravascular techniques to stabilize and extract the thrombus can be utilized in unstable patients when the threat of pulmonary embolism is high. Critically ill and unstable patients with large, complex, and organized thrombi can benefit from the use of the presented novel, efficient, and safe approach, guarding against thrombus embolization during thrombectomy.

## 1 | Background

Right heart thrombi arise either as emboli from deep peripheral venous system thrombi (Type A) or occur in situ in the right heart (Type B), often associated with indwelling catheters or in the right atrial appendage, all posing a significant risk of thromboembolization [1]. Pulmonary embolism (PE) secondary to venous thromboembolism is a leading cause of cardiovascular morbidity and mortality in the United States leading to a great burden on the patient and on medical resources [2]. Due to a rapid increase in the pulmonary artery pressure caused by the occlusion of a PE, fatal right ventricular failure can ensue [2]. Systemic anticoagulation and thrombolysis may be ineffective or contraindicated in cases involving large, organized thrombi [3, 4]. The high risk of thromboembolism makes transcatheter extraction of large thrombi challenging, especially with the limitations of existing endovascular techniques. Surgical removal of thrombi at the cavoatrial junction often involves cardiopulmonary bypass [5]. We describe a novel,

minimally invasive percutaneous approach for safe and effective thrombus removal in the pediatric catheterization setting using a coaxial system of Penumbra Lightning Thrombectomy catheter (Penumbra Inc., Alameda, CA, USA) inside a ÖNÖ Retrieval Device (B. Braun, Bethlehem, PA, USA) used for protection from embolization.

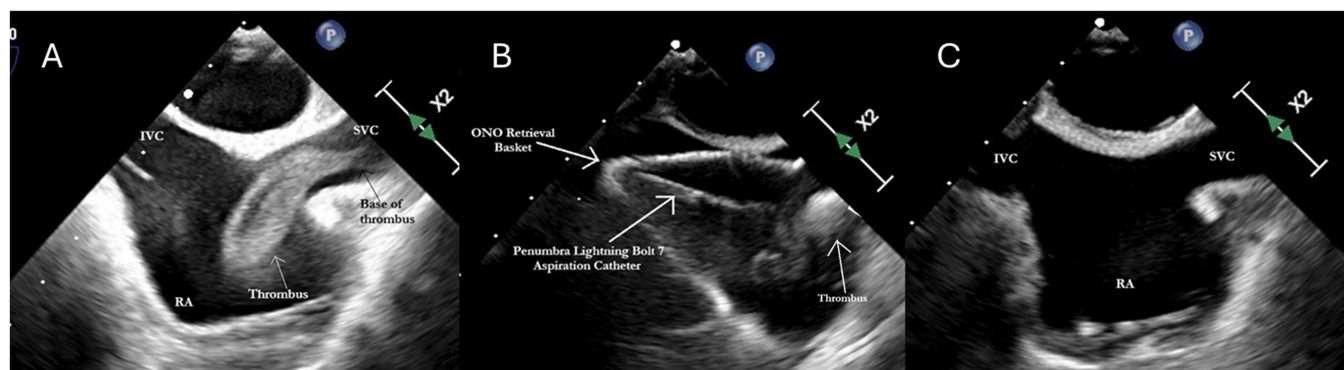
## 2 | Case Presentation

A 12-year-old, 32-kg patient with transfusion-dependent Fanconi anemia status post-bone marrow transplant (BMT) and steroid-resistant graft-versus-host disease (GVHD) on a steroid taper presented with new-onset dyspnea and upper extremity swelling. Cross-sectional imaging was negative for PE, but confirmed a large thrombus at the right atrium–superior vena cava (RA-SVC) junction seen on echocardiogram, for which he was urgently referred to the catheterization laboratory. Patient had a history of a long-dwelling catheter with tip at the

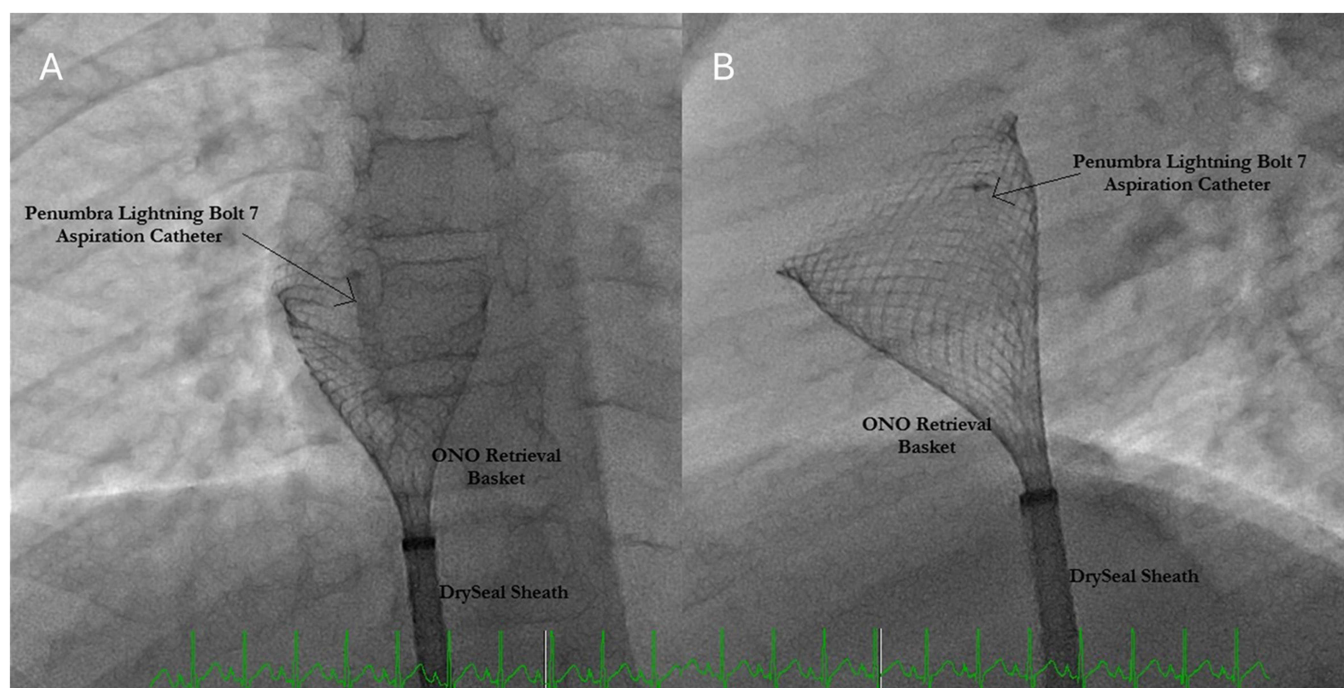
cavoatrial junction that was removed 1 week prior to presentation, and no thrombus was seen on previous echo 27 days prior to presentation. Transesophageal echocardiography (TEE) was used in the catheterization laboratory to confirm the thrombus size, location, and attachment (Figure 1).

Femoral venous access was obtained, and a 4 Fr Glide catheter with a 0.035" Terumo Glidewire (Terumo Medical, Somerset, NJ, USA) was advanced from the right femoral vein to the RA-SVC junction. The Glidewire was exchanged for a 0.035" Amplatzer SuperStiff wire (Amplatzer Medical Corp., Golden Valley, MN, USA), and the access system was upsized to a 12 Fr DrySeal sheath (GORE Medical, Newark, DE, USA). The Penumbra Lightning Bolt 7 Fr thrombectomy aspiration catheter in combination with a B. Braun  $\bar{O}\bar{N}\bar{O}$  retrieval basket in a coaxial system, facilitated thrombus extraction while minimizing embolic risk.

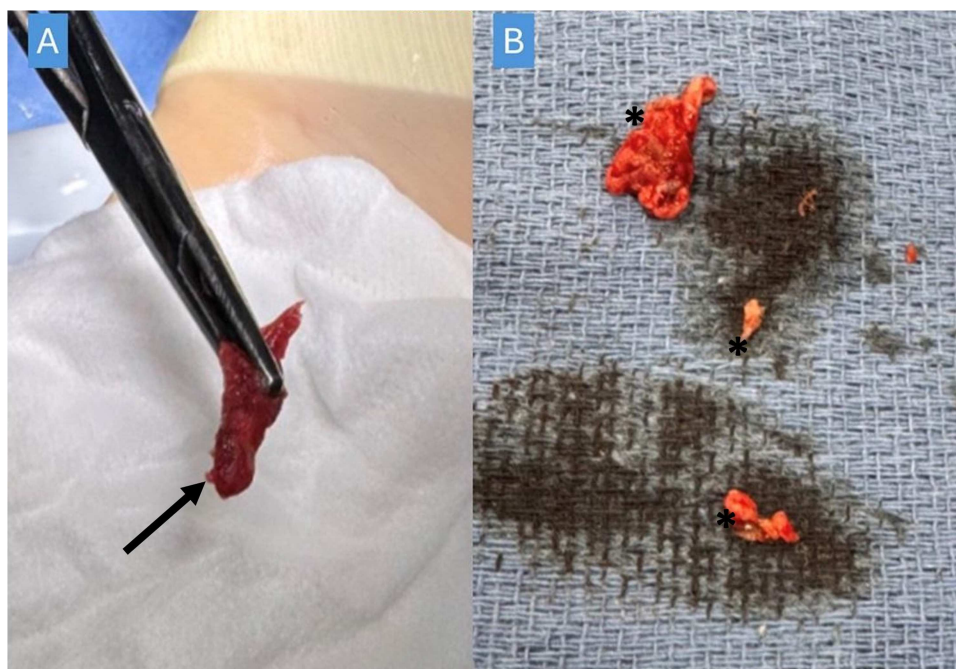
The  $\bar{O}\bar{N}\bar{O}$  retrieval basket was advanced through the DrySeal sheath under continuous TEE and fluoroscopic guidance (Figures 1 and 2, respectively). The basket was deployed and carefully manipulated to encompass and stabilize the thrombus, creating a protective barrier against distal embolization. The Penumbra Lightning Bolt aspiration catheter was then introduced coaxially through the basket over a 0.014" wire. With the thrombus securely encased, aspiration was initiated using the system's intelligent vacuum controller under TEE guidance. The thrombus was progressively mobilized, though difficult to completely aspirate, thus continuous suction through the Lightning system was applied to grip the thrombus and peel it off the atrial wall and into  $\bar{O}\bar{N}\bar{O}$  retrieval basket, allowing for controlled, complete removal (Figure 3). The entire system was subsequently withdrawn as a single unit under echocardiographic and fluoroscopic monitoring to ensure thrombus



**FIGURE 1** | Transesophageal echocardiography at standard mid-esophageal, bicaval view. (A) Shows the elongated thrombus measuring 26 mm  $\times$  8 mm is seen attached only proximally at the SVC with a narrow base of 3.15 mm and extending from the SVC to the RA. (B) Shows  $\bar{O}\bar{N}\bar{O}$  retrieval basket with the Penumbra Lightning Bolt 7 aspiration catheter starting to aspirate the thrombus. (C) Shows full extraction of the thrombus without any residual remaining and removal of coaxial system. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.70638)]



**FIGURE 2** | Fluoroscopy with straight AP (A) and lateral (B) views of the  $\bar{O}\bar{N}\bar{O}$  retrieval basket and the Penumbra Lightning Bolt 7 aspiration catheter in place to begin aspiration of the thrombus. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.70638)]



**FIGURE 3** | Image of the extracted clot using the ÖNÖ retrieval basket and the Penumbra Lightning Bolt 7 aspiration catheter in tandem. Smaller specimens were aspirated (\*) while larger thrombus (arrow) required continuous suction for mechanical removal. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.70638)]

clearance and confirm the absence of embolic dispersion (Figure 1).

### 3 | Discussion

Thrombus at the RA-SVC has a high risk of potential embolization into the pulmonary circulation [1, 6]. While surgical thrombectomy remains an option, it often involves bypass and carries significant morbidity, especially in immunocompromised or high-risk pediatric patients [1, 7]. Thrombectomy using suction filtration on venovenous bypass has been previously described [8].

However, this case highlights the successful use of a novel percutaneous strategy combining mechanical stabilization with advanced aspiration to safely extract thrombus at the RA-SVC junction without the need for venovenous or cardiopulmonary bypass. The B. Braun ÖNÖ retrieval basket functioned as both a stabilizing and embolic protection device, while the Penumbra Lightning Bolt catheter enabled controlled aspiration through intelligent vacuum feedback.

This novel percutaneous approach was successfully completed in a 12-year-old patient with a large thrombus at the RA-SVC junction without complications. The patient was initiated on rivaroxaban prior to discharge and remained clinically stable. At a 4-month follow-up, repeat imaging demonstrated no thrombus recurrence, and the patient remained asymptomatic on anticoagulation therapy. The etiology of the thrombus remains unclear, but it was likely a subacute thrombus, as it was partially adherent to the wall and not present on echocardiogram less than 1 month prior, due to a combination of an indwelling catheter and their hypercoagulable state—due to GVHD [9] and steroid taper [10]. As there are no societal guidelines for management of right heart thrombi in the absence of concomitant PE [6], clinical risk factors, assessed in conjunction with

hematology, were considered too great to treat only with anticoagulation. The risk of embolization was thought to be too great to attempt a simple snaring of this large thrombus.

Use of the ÖNÖ retrieval basket for right atrial thrombi [11, 12] and for removal of embolized devices [13, 14] has been documented. However, this is the first described case, to our knowledge, of the use of the ÖNÖ retrieval basket in a coaxial system with an aspiration catheter to stabilize the thrombus and prevent embolization while using the thrombectomy catheter for mechanical removal. The ÖNÖ retrieval basket is ideal for this technique in older/larger patients that can tolerate a 12 Fr vascular sheath. Additionally, the 7 Fr lumen of the ÖNÖ basket allows for the coaxial system used in this case and can accommodate the smaller Penumbra Thrombectomy catheters, which are 6 Fr and 7 Fr catheters, both in straight and angled tip configurations. This could be considered both in right-sided extractions, but also in left-sided extractions, where the ÖNÖ retrieval basket could be parked in the ascending aorta and serve as a cerebral protection device.

The favorable clinical course, absence of complications, and sustained thrombus resolution at follow-up underscore the safety and feasibility of this technique in select high-risk patients. The use of post-procedural anticoagulation with rivaroxaban likely contributed to the absence of thrombus recurrence. While limited to a single case, this approach represents a promising alternative to open surgery or pharmacologic therapy for managing complex central venous thrombi. Further studies in larger cohorts are warranted to establish reproducibility, safety, and long-term efficacy.

### 4 | Conclusion

Critically ill and unstable patients with large, complex thrombi or thrombi-in-transit can benefit from the use of fast and safe

minimally invasive approaches while adding protection for potential embolization of the thrombus during thrombectomy. The use of the coaxial system of a Penumbra Thrombectomy catheter and the  $\bar{O}\bar{N}\bar{O}$  retrieval basket can provide such an option for quick and effective thrombus removal.

### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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