Atraumatic Pulmonary Valve Crossing to Enable Successful Embolization of Multiple Pulmonary Arteriovenous Malformations after Failed Attempts

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AUTHORS' CONTRIBUTIONS

All authors contributed to the manuscript conception and design. Material preparation, data collection and analysis were performed by [Symeon Lechareas], [Melpomeni Spyropoulou], [Marianna Vlychou] and [Georgios Papageorgiou]. The first draft of the manuscript was written by [Symeon Lechareas] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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DISCLOSURES

The authors declare that they have no conflict of interest

CONSENT

yes

HUMAN AND ANIMAL RIGHTS

N/A

ABSTRACT

Pulmonary Arteriovenous Malformations (PAVMs) are an important cause of right-to-left shunting and paradoxical embolic events, particularly in patients with Hereditary Hemorrhagic Telangiectasia (HHT). Endovascular embolization is the treatment of choice, but prior unsuccessful attempts may complicate subsequent management. We report a 48-year-old woman with genetically confirmed HHT and progressive hypoxemia, in whom two earlier embolization procedures were aborted due to ventricular ectopy and transient tachyarrhythmia. Under general anesthesia, atraumatic pulmonary valve crossing was achieved using a 4 Fr angled pigtail catheter, enabling successful embolization of five PAVMs in a single session with microvascular plugs and detachable coils. No arrhythmias occurred, and oxygen saturation improved from 92% to 98%. This case highlights the value of tailored procedural planning—including catheter selection and anesthesia—in preventing arrhythmia-related complications and achieving complete treatment in technically challenging or previously failed PAVM interventions.

CASE REPORT

Case Presentation

A 48-year-old woman with genetically confirmed HHT presented with exertional dyspnea, resting oxygen saturation of 92%, and a history of chronic cerebellar stroke (Figure 1). Two previous embolization attempts at other institutions were aborted due to frequent ventricular ectopy and transient ventricular tachycardia during guidewire manipulation in the right ventricular outflow tract. Pre-procedural CT angiography demonstrated five PAVMs—two in the right lung and three in the left—with five dominant feeding arteries.

Imaging Findings

Pre-procedural CT angiography demonstrated the known bilateral PAVMs with feeding artery diameters of 3–5 mm (Figure 2a).

Management and Follow-up

The procedure was performed under general anesthesia for hemodynamic stability, airway control, and rhythm suppression. Right common femoral venous access was obtained, and a 4 Fr angled pigtail catheter (Terumo Medical Corporation, Somerset, NJ, USA) was used to minimize right ventricular irritation. No arrhythmias occurred during manipulation of the catheter in the pulmonary valve not pulmonary artery valve.

Selective angiography confirmed the presence of 2 large PAVMs on the right side (Figure 3a) and three on the left (Figure 4a). Embolization was performed using microvascular plugs (MVP-5Q and MVP-7Q, Medtronic) and detachable coils for more proximal feeders. Seven plugs and three coils were deployed in total (Figures 3b,4b). Total procedure time was 90 minutes without complications. Post-procedure, oxygen saturation improved to 98% at rest and during exertion. The patient was started on short-term prophylactic and then transitioned to a direct oral anticoagulant to a direct oral anticoagulant (DOAC) for three months to prevent device-related thrombosis. Three-month follow-up CT angiography confirmed durable occlusion of all treated PAVMs (Figure 1b).

DISCUSSION

Embolization of PAVMs effectively eliminates right-to-left shunting and reduces neurologic complications. However, repeated or complex interventions may be technically challenging, especially in patients with previous failed procedures or arrhythmia susceptibility. In this case, prior failures were likely due to mechanical irritation during right heart catheterization rather than intrinsic conduction abnormalities.

Etiology & Demographics

PAVMs are abnormal direct communications between pulmonary arteries and veins and are most commonly associated with HHT. They occur more frequently in women and may enlarge over time or during pregnancy [1,2].

Clinical & Imaging Findings

Patients may present with hypoxemia, dyspnea, or paradoxical embolic events. CT angiography is the gold standard for diagnosis, and contrast echocardiography is highly sensitive for shunt detection [2,3].

Treatment & Prognosis

Endovascular embolization is first-line therapy, with high success rates using microvascular plugs and coils [3,4]. Atraumatic pulmonary valve crossing is crucial in arrhythmia-prone patients. Use of a soft-tipped, angled pigtail catheter minimizes right ventricular irritation and eliminates arrhythmia risk. Although these catheters are less commonly available, their design provides excellent stability and atraumatic passage through the pulmonary valve, especially valuable in patients with prior arrhythmogenic episodes. This might be the standard of care in large HHT centers but this is not the case for low volume centers that perform PAVM embolization sporadically.

Prognosis is favorable following complete embolization, with recommended follow-up imaging at 6–12 months and every 3–5 years thereafter [2].

Differential Diagnosis

Differential considerations include pulmonary varices, hemangiomas, bronchial artery–pulmonary vein fistulas, hepatopulmonary syndrome, and congenital right-to-left shunts. CT angiography reliably distinguishes these based on vascular anatomy and feeding artery configuration [5].

TEACHING POINT

Safe and effective embolization of PAVMs requires meticulous pre-procedural planning and the use of atraumatic catheterization techniques, such as soft-tipped pigtail catheters, to prevent arrhythmias. Tailored procedural planning including the implementation of general anesthesia improves outcomes in complex or previously failed interventions.

QUESTIONS

1. Which imaging modality is considered the gold standard for characterization of PAVMs?
   A. Chest X-ray
   B. CT angiography
   C. Ventilation–perfusion scan
   D. Non-contrast MRI
   Correct answer: B

2. What was the most likely cause of the arrhythmias during prior embolization attempts?
   A. Electrolyte imbalance
   B. Underlying conduction disease
   C. Mechanical irritation of the right ventricular outflow tract
   D. Reperfusion injury
   Correct answer: C

3. Which catheter enabled atraumatic pulmonary valve crossing in this case?
   A. 6 Fr multipurpose catheter
   B. 7 Fr Judkins catheter
   C. 4 Fr angled pigtail catheter
   D. 5 Fr Simmons catheter
   Correct answer: C

4. In HHT patients, PAVMs are most commonly associated with which complication?
   A. Pulmonary fibrosis
   B. Left-to-right shunting
   C. Paradoxical embolic stroke
   D. Recurrent pneumothorax
   Correct answer: C

5. What is the recommended interval for follow-up imaging post-embolization?

A. Every 6 months

B. At 6–12 months, then every 3–5 years

C. Yearly for life

D. No follow-up needed

Correct answer: B

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FIGURES

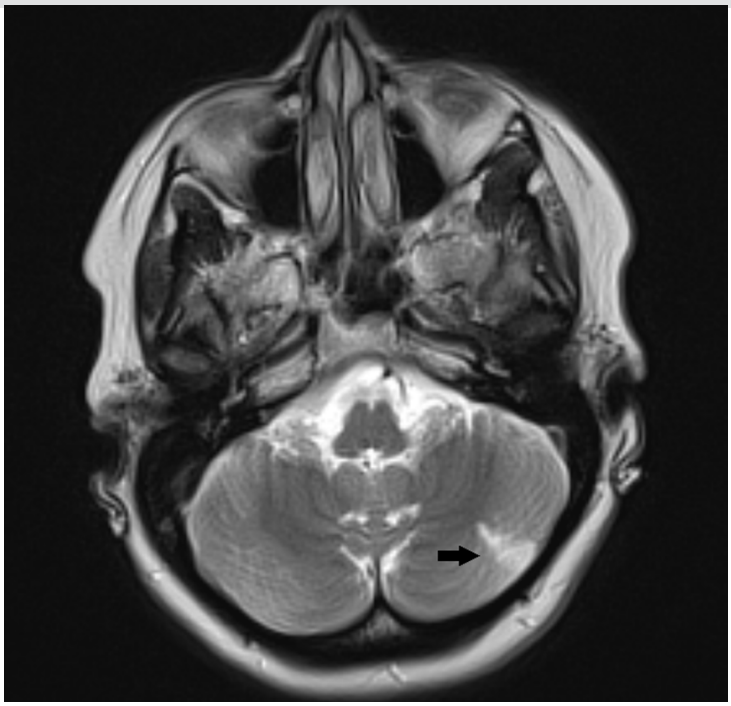

Figure 1: Axial T2-weighted MRI of the brain demonstrating increased signal intensity within the left cerebellum, consistent with a prior infarct (black arrow).

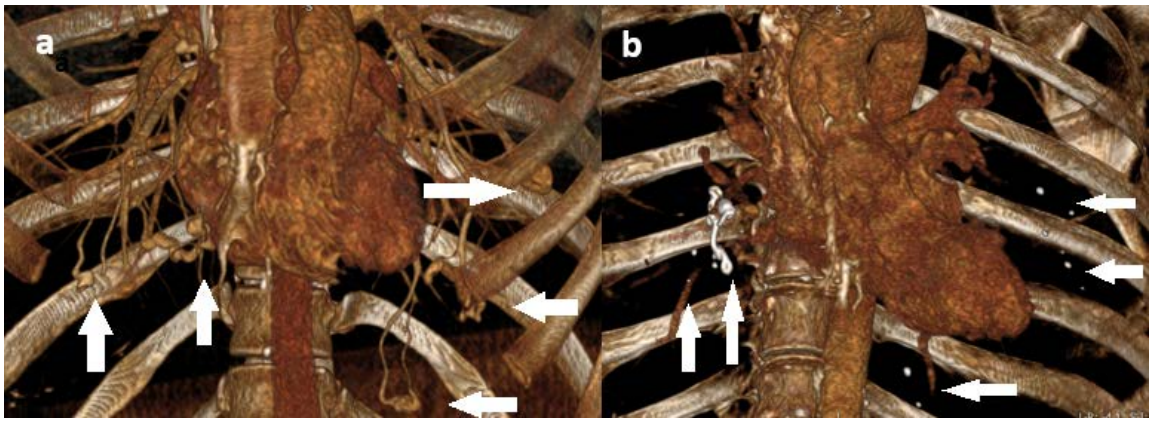

Figure 2: 3D volume-rendered CT angiography illustrating the PAVMs. (a) Pre-embolization image showing multiple PAVMs with their feeding vessels (white arrows). (b) Image at 3-month follow-up demonstrating the embolic materials and complete obliteration of the PAVMs (white arrows).

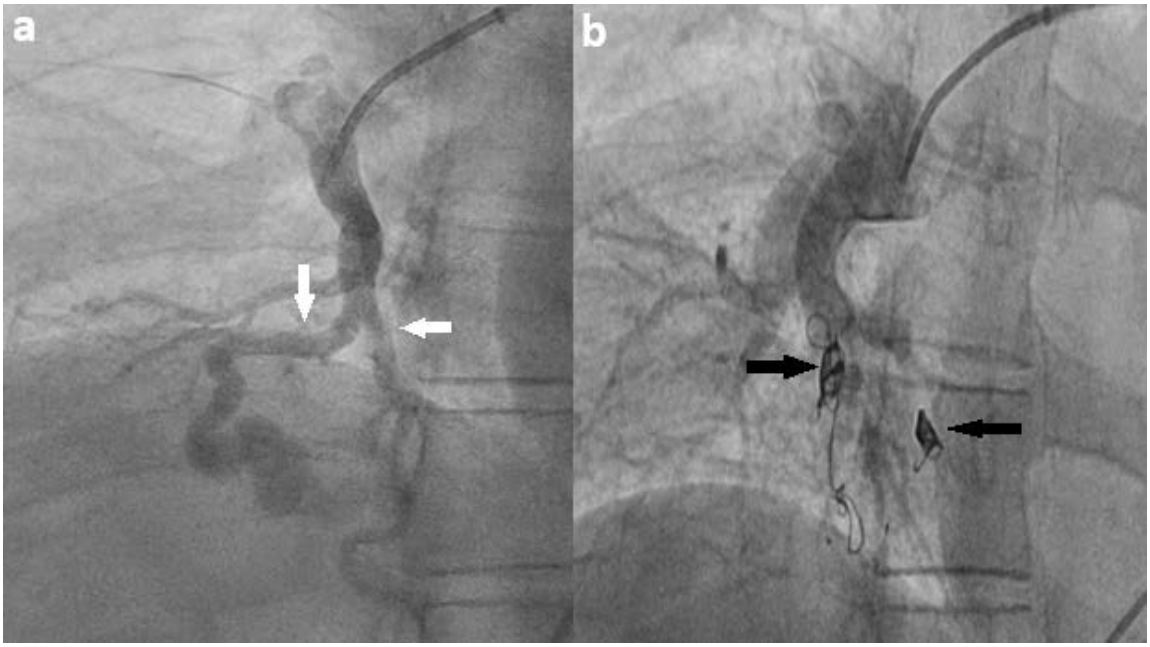

Figure 3: Angiographic images of the right pulmonary artery. (a) Pre-embolization angiogram showing two high flow PAVMs with prominent feeding arteries (white arrows). (b) Post-embolization angiogram demonstrating complete occlusion of the PAVMs with plugs and coils and no residual filling (white arrows).

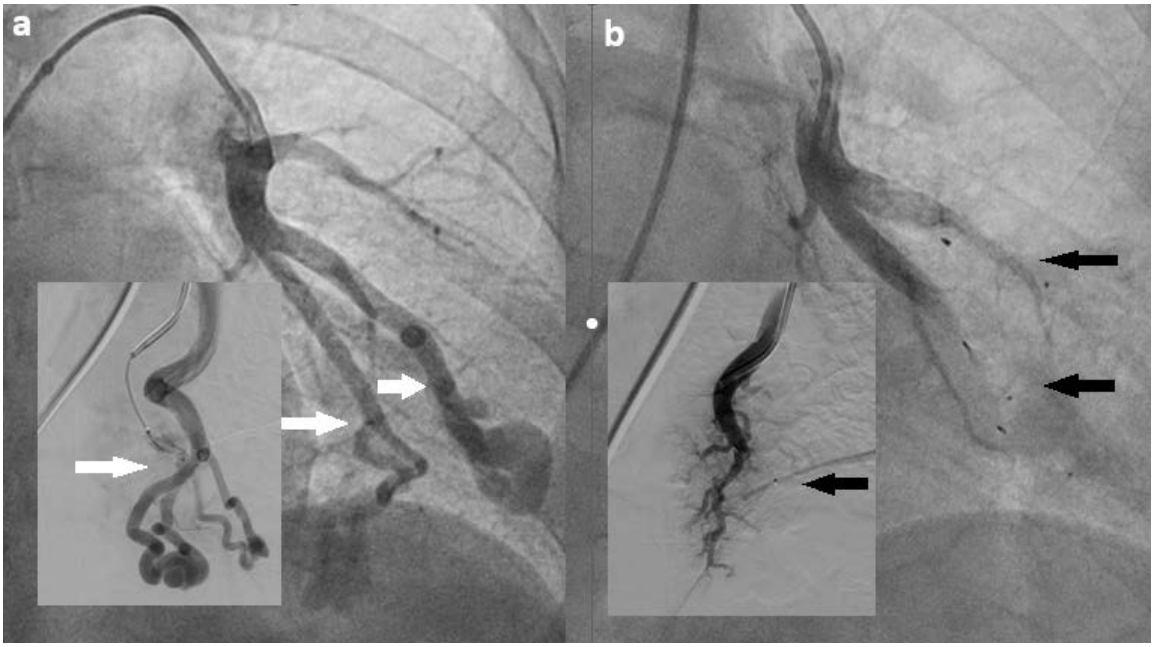

Figure 4: Angiographic images of the left pulmonary artery. (a) Pre-embolization angiogram showing three PAVMs with prominent feeding arteries (white arrows). (b) Post-embolization angiogram demonstrating occlusion of the PAVMs achieved with vascular plugs, and absence of residual flow (black arrows).

KEYWORDS

Pulmonary arteriovenous malformation, hereditary hemorrhagic telangiectasia, embolization, interventional radiology