CT-Guided Percutaneous Embolization of a Rasmussen Aneurysm with Ethylene Vinyl Alcohol Copolymer

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Rasmussen aneurysm is a peripheral pulmonary artery (PA) pseudoaneurysm that occurs due to erosion of a PA branch adjacent to or within a tuberculous (TB) cavity (1). Rupture of a Rasmussen aneurysm can cause life-threatening hemoptysis requiring aggressive management, making endovascular treatment a recommended therapeutic modality (1). We present a computed tomography (CT)-guided direct percutaneous puncture and embolization of a TB-associated PA pseudoaneurysm with ethylene vinyl alcohol (EVOH) copolymer (Squid-18, Emboflu, Switzerland). Institutional Review Board approval was waived for this case report and the patient consented to the use of the data for scientific purposes.

The patient was a 37-year-old man with a history of active pulmonary tuberculosis under anti-TB therapy who presented with massive hemoptysis. Thoracic CT angiography identified a 2-cm pseudoaneurysm in the superior segment of the right lower lobe (**Fig 1**). Right bronchial arteriography revealed hypertrophy without pseudoaneurysm evidence (**Fig E1** [available online on the article's Supplemental Material page at *www.jvir.org*]). Embolization of the right bronchial artery was performed with 350–500 μm polyvinyl alcohol particles (Merit Medical, South Jordan, UT) (**Fig E2** [available online on the article's Supplemental Material page at *www.jvir.org*]). Hemoptysis recurred the next day and a second CT angiography confirmed the persistence of the pseudoaneurysm. The patient was medicated with tranexamic acid (2 g intravenously in the following 24 hours) in an attempt to lessen hemoptysis, without success, requiring emergent intubation and ventilator support. A bronchofibroscopy revealed active hemorrhage in right upper lobar bronchus and multiple clots in left main bronchus and distal branches. At this stage, the patient was experiencing massive hemoptysis with hemodynamic instability and he was referred to the author's institution. After reviewing previous CT angiographies and considering the failed bronchial artery

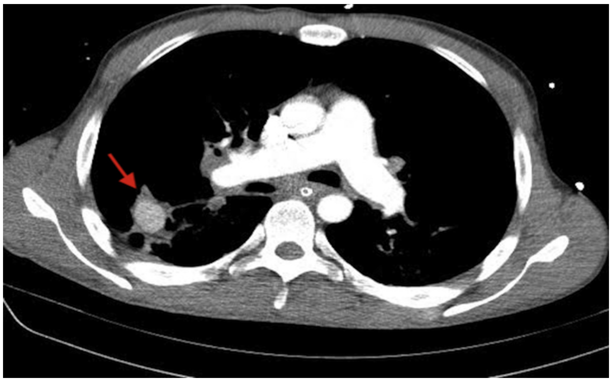

Figure 1. Axial CT angiography of the thorax depicting the Rasmussen aneurysm (arrow).

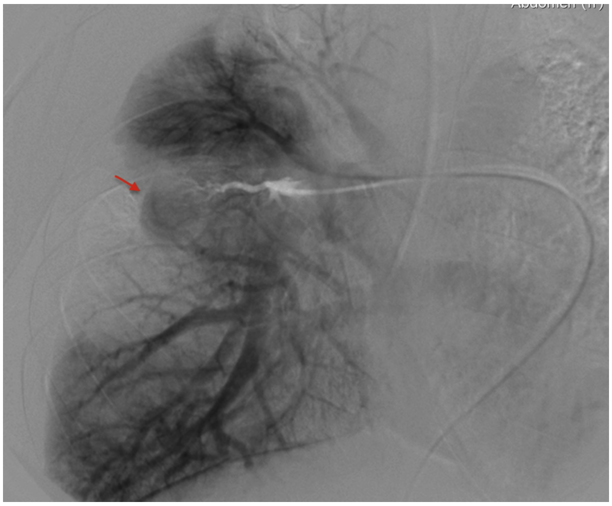

Figure 2. Selective pulmonary arteriography, late phase, depicting the Rasmussen aneurysm filling with no obvious feeding vessel (arrow).

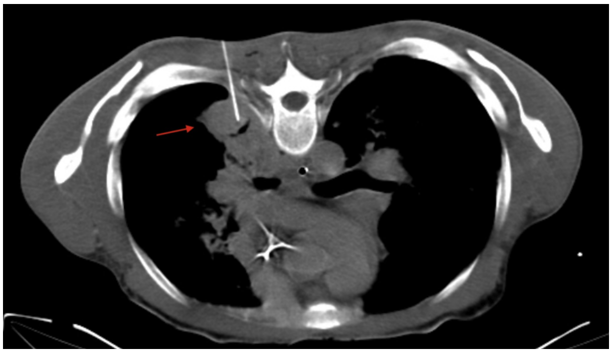

Figure 3. CT-guided puncture of the Rasmussen aneurysm (arrow).

F.V.G. is a paid consultant for Terumo (Tokyo, Japan). T.B. receives personal fees from Merit Medical (South Jordan, Utah), Terumo, and Philips (Eindhoven, The Netherlands), and owns stock in EmbolX (Sunnyvale, California). None of the other others have identified a conflict of interest.

Figures E1–E4 can be found by accessing the online version of this article on *www.jvir.org* and clicking on the Supplemental Material tab.

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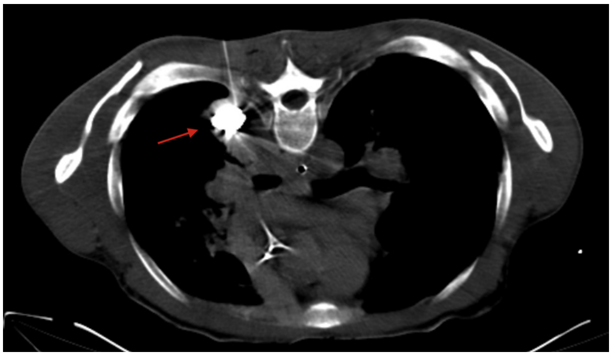

Figure 4. Filling of the Rasmussen aneurysm (arrow) with EVOH.

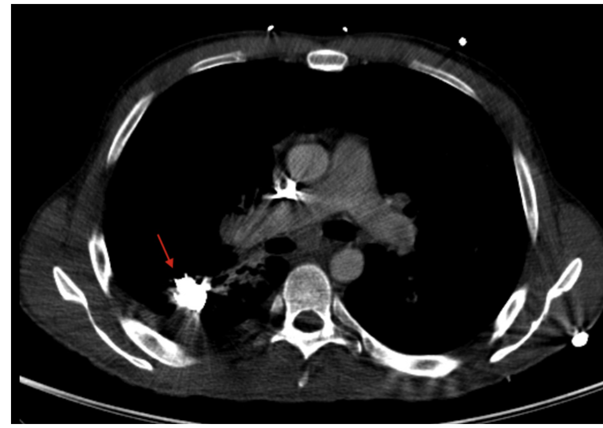

Figure 5. Axial CT angiography of the thorax 4 days after the procedure depicting the Rasmussen aneurysm filled with EVOH (arrow).

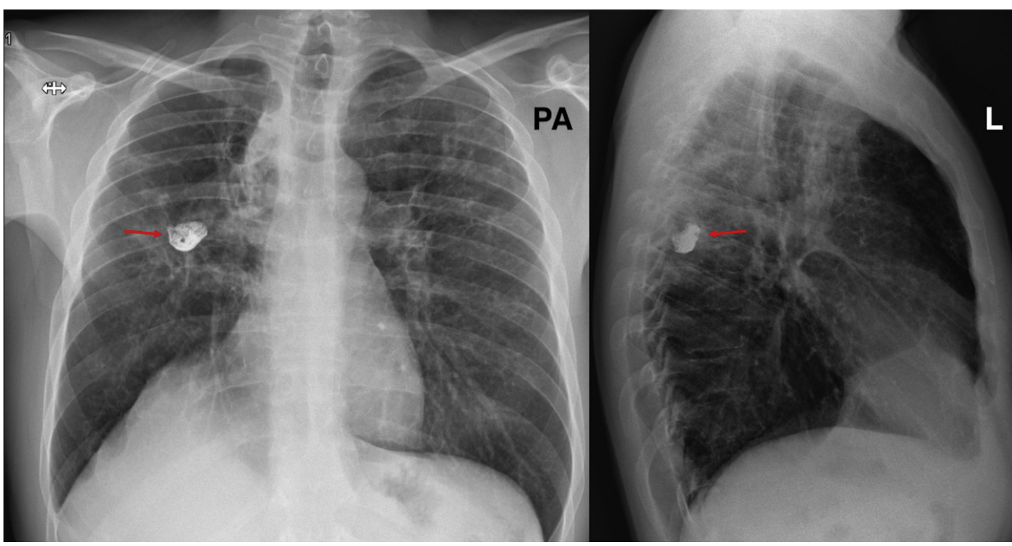

Figure 6. Posteroanterior (PA) and lateral (L) chest radiographs 4 months after intervention demonstrating the embolic agent retained in the lesion (arrows).

embolization, the PA was hypothesized the origin of the pseudoaneurysm.

In the angiographic suite, selective arteriograms of the right branch of the PA identified the pseudoaneurysm in a late phase (**Fig 2**). Superselective catheterization of the right PA branches did not demonstrate the culprit branch (**Figs E3**, **E4** [available online on the article's Supplemental Material page at *www.jvir.org*]). The patient was transferred to the CT room, placed in the prone position, and the PA pseudoaneurysm was punctured directly under CT guidance with a 21-G needle (**Fig 3**). After confirming reflux of blood through the needle, the dead space of the needle was filled with 0.2 mL of dimethyl-sulfoxide. Two vials (3 mL) of Squid-18 were manually injected into the pseudoaneurysm at a rate of 0.2 mL/min under CT fluoroscopy (**Fig 4**). Control CT scan confirmed PA pseudoaneurysm filling. The angiography lasted 150 minutes, whereas the CT-guided procedure lasted 30. The following day, hemoptysis resolved and the patient was extubated with an uneventful course. CT angiography was performed 4 days later showing the Rasmussen aneurysm filled with EVOH (**Fig 5**). Up to 4 months after the procedure, there was no recurrent bleeding, and a chest radiograph showed the embolic agent retained in the lesion (**Fig 6**).

The failure of pulmonary angiography to visualize a major feeding vessel or to clearly visualize the pseudoaneurysm has been described previously (2,3). Direct ultrasonography (US)- and fluoroscopy-guided PA pseudoaneurysm puncture and embolization has been performed using different embolic agents such as thrombin (3), *N*-butyl cyanoacrylate (3), and coils (2) with success. In this patient, CT guidance was preferred over US or fluoroscopy because of the posterior location of the PA pseudoaneurysm with interposed aerated lung. Unlike the present report, in which the PA pseudoaneurysm is located within a lung consolidation, the US-guided puncture is a viable option (2,3). Direct percutaneous aneurysm sac injection of EVOH through a needle to treat aortic type II endoleaks has been described previously (4). The rationale for its use in this type of situations is based on the consistent filling of the aneurysm sacs and feeding vessels, allowing controlled complete occlusion with limited untargeted embolization. The reduced inflammatory reaction induced by EVOH is also noted as a potential advantage (4). EVOH was preferred over thrombin because it is radiopaque and easier to monitor during delivery. It was preferred over *N*-butyl cyanoacrylate because it is a nonadhesive liquid embolic agent without the risk of the needle getting stuck. Coils were considered more complex to deliver, usually requiring exchange of the needle with a catheter (2). EVOH, being a liquid embolic, is easy to deliver through a needle, with reliable filling of the lesion and possible collateral shunts. The controlled injection of EVOH allows to prevent untargeted embolization through eventual systemic-to-PA shunts because the progression of the embolic agent follows a lavalike flow pattern (4) dependent on the rate of injection. In addition, PA pseudoaneurysm embolization with direct injection of EVOH through a percutaneously inserted needle may allow to successfully perform this type of procedures faster than the transcatheter route and may be a viable first-line approach. Limitations of this report are based on the anecdotal nature of a single treated patient with limited durable proof.

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Combined Intravascular Ultrasound and Fluoroscopy-Guided Removal of a Radiolucent Foreign Body from the Right Pulmonary Artery

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Fluoroscopy provides high image contrast of radiopaque foreign bodies and retrieval devices relative to the surrounding soft tissues with nearly instantaneous feedback of retrieval maneuvers and position. Intravascular foreign bodies that are not opaque on radiography, however, present a challenge to fluoroscopy-guided retrieval. This case describes the combined use of intravascular ultrasound (IVUS) and fluoroscopy for the removal of a radio occult foreign body in the right pulmonary artery.

Case 1: Ins titutional research policy exempts case reports from Institutional Review Board approval. A 30-year-old morbidly obese woman (body mass index of 55.9) with sickle cell disease, a history of multiple cerebrovascular accidents, and recurrent catheter-associated blood stream infections requiring multiple line removals presented with diminished consciousness. Associated fever (101.5°F [38.6°C]), tachycardia (heart rate of 115 beats per min), and hypoxia (transient oxygen saturation <70%) prompted further workup for sepsis and pulmonary embolism. A computed tomography (CT) angiogram of the pulmonary arteries demonstrated a tubular foreign body 6.7 cm in length in the right pulmonary artery 1.5 cm distal to the main pulmonary artery bifurcation and extending into the origin of the right interlobar pulmonary artery (Fig 1). Until the CT angiogram was performed, the

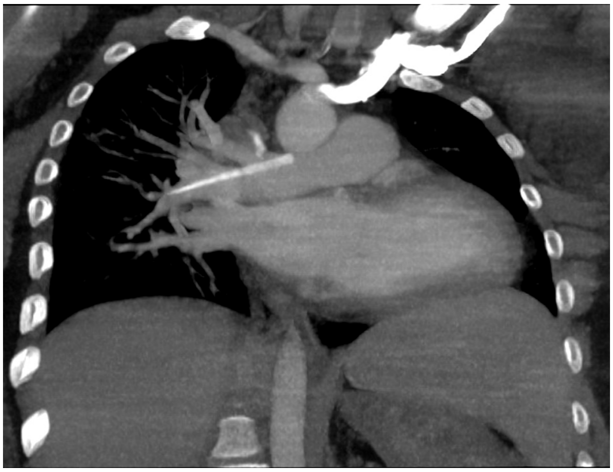

Figure 1. Coronal maximal intensity projection image constructed from a pulmonary embolism protocol CT performed for hypoxia demonstrates a linear foreign body in the right pulmonary artery.

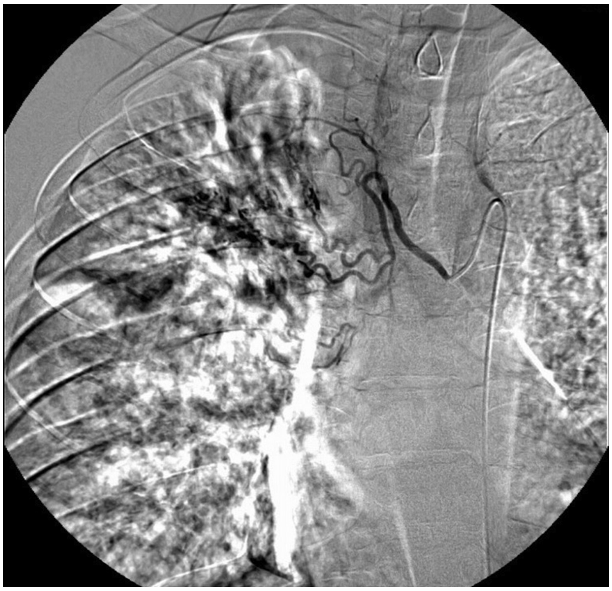

Figure E1. Right bronchial arteriogram with no evidence of pseudoaneurysm.

Figure E2. Right bronchial arteriogram after embolization.

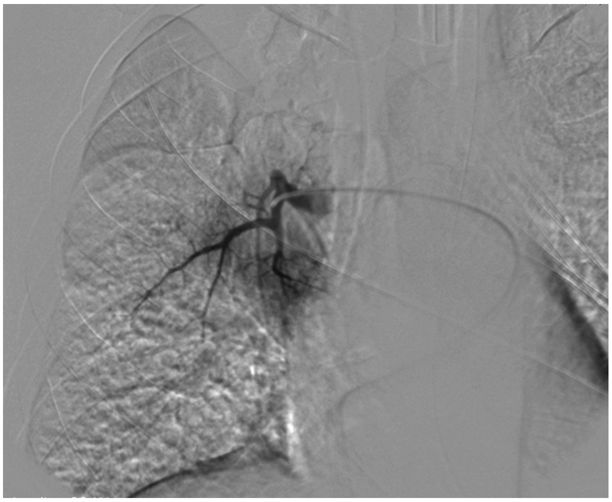

Figure E3. Arteriography of the right middle pulmonary artery branch did not demonstrate the pseudoaneurysm.

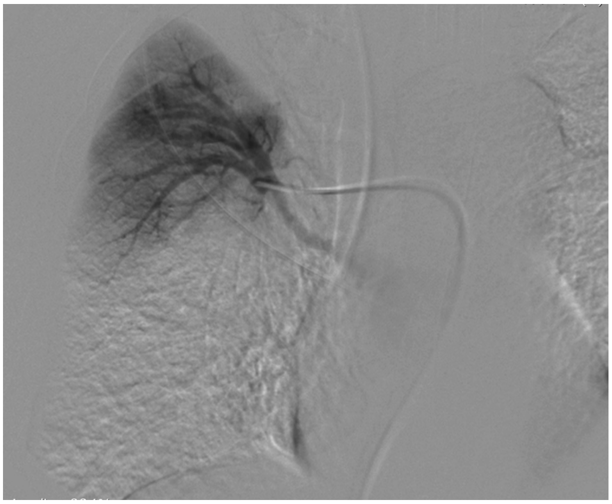

Figure E4. Arteriography of the upper branches of the right lower pulmonary artery did not demonstrate the pseudoaneurysm.