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Embolization of a Pulmonary Arteriovenous Malformation

BY JOHN J. PARK, MD, PHD

CASE PRESENTATION

A 50-year-old woman presented with a newly diagnosed right pulmonary arteriovenous malformation (PAVM) discovered during follow-up imaging after a cholecystectomy. The patient denied a history of stroke, transient ischemic attack, epistaxis, hemoptysis, dyspnea/hypoxia, exercise intolerance, or other symptoms related to right-to-left shunting. The cardiac and pulmonary physical examinations were unremarkable, including for murmurs or audible bruits. The patient had no family history of hereditary hemorrhagic telangiectasia or other risk factors for lymphovascular malformations. Her preprocedural contrast-enhanced CT demonstrated a 1-cm PAVM (simple type) with a single feeding artery (segmental pulmonary artery) ranging from 2.8 to 3.4 mm in diameter and a single draining vein (pulmonary vein) measuring 4.1 mm (Figure 1). On further workup, the patient had no evidence of cardiac abnormalities or other respiratory diseases. Her past medical and surgical histories were significant only for symptomatic cholelithiasis requiring cholecystectomy. Despite the lack of clinical symptoms, given the increased risk of future adverse events (feeding vessel > 3 mm),[1] the decision was made to proceed with transcatheter embolization of the PAVM.

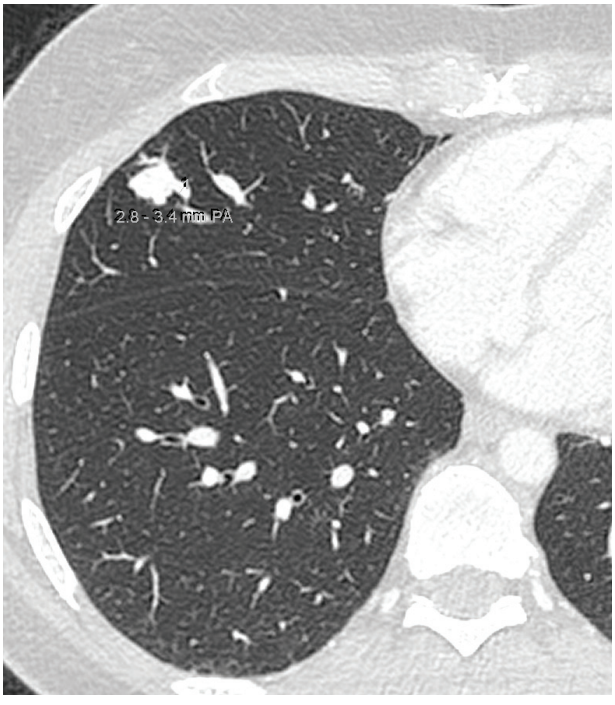

Figure 1. CT pulmonary angiogram demonstrating a right PAVM with a single feeding vessel (2.8–3.4 mm) and draining vein (not shown).

PROCEDURE DESCRIPTION AND FOLLOW-UP

The outpatient procedure was performed under moderate sedation. The patient was maintained on therapeutic heparin throughout the procedure. Using ultrasound guidance, the right common femoral vein was accessed and a 7-F X 70-cm vascular sheath was placed. The pulmonary artery was catheterized, and the vascular sheath was advanced into the main pulmonary artery, followed by placement of a 5-F pigtail flush catheter. Pulmonary artery pressure measurements were obtained (pulmonary artery pressure, 25/5 mm Hg; mean, 14 mm Hg), and pulmonary arteriography was performed. The pigtail catheter was exchanged for a 5-F Glidecath (Terumo Interventional Systems), which was used to select the right pulmonary artery and branches; subsequent arteriography was performed, which demonstrated a simple type PAVM with a solitary segmental feeding vessel and early draining vein (Figure 2). Once

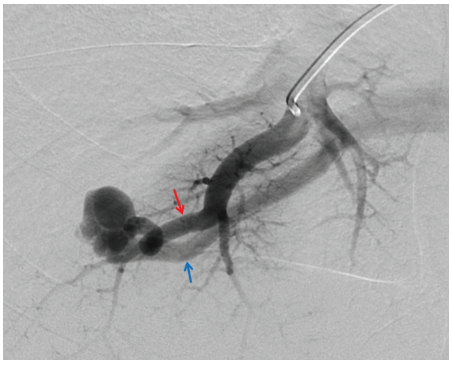

Figure 2. Digital subtraction angiogram of a branch of the right pulmonary artery demonstrating a solitary segmental pulmonary artery (red arrow) supplying the PAVM (simple type) with single early draining vein (blue arrow).

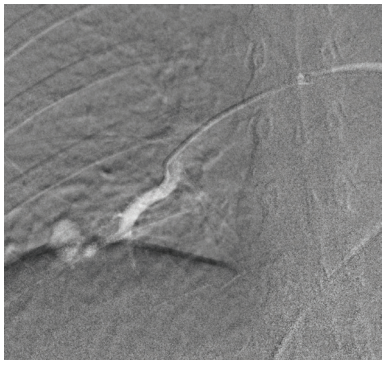

Figure 3. Road map of the segmental feeding artery for microcatheter delivery of the MVP-5Q™ plug.

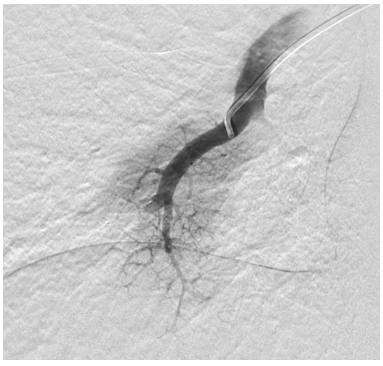

Figure 4. Immediate postdetachment angiogram of the MVP-5Q™ plug within the distal segmental pulmonary artery demonstrating immediate occlusion of the feeding artery.

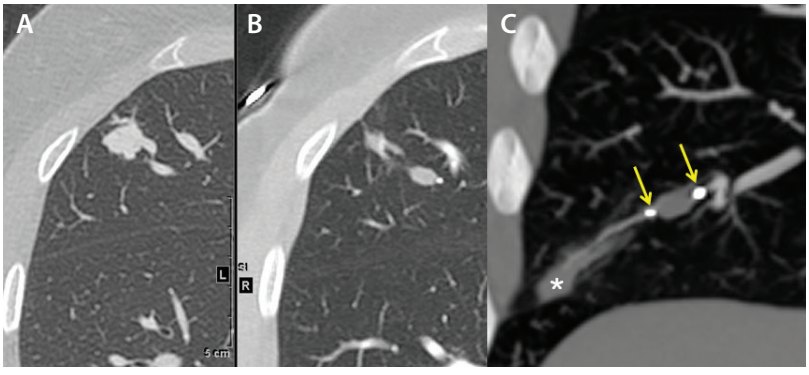

Figure 5. CT pulmonary angiogram. Pretreatment CTA demonstrating the PAVM and feeding vessel (A). Follow-up CTA at 3 months demonstrating involution of the PAVM and no further enhancement (B). Coronal multiplanar reformat image showing the stability of the MVP™ plug within the thrombosed feeding artery (yellow arrows show the radiopaque markers of the MVP-5Q™ plug) (C). Asterisk (*) signifies a small area of distal infarct with scarring.

the feeding vessel to the PAVM was identified, a road map was performed (Figure 3), a 2.8-F Rebar microcatheter (Medtronic) was used to select the distal feeding artery, and a 5-mm MVP™ microvascular plug (MVP-5Q; Medtronic) was placed and deployed. Once optimal placement was confirmed, the MVP-5Q was detached from the delivery wire, and a postembolization arteriogram demonstrated complete occlusion of the main feeding vessel and no further opacification of the PAVM (Figure 4). No definite additional feeding branches were identified during subsequent segmental artery interrogations.

After the procedure, there were no adverse events or complications. At her 3-month clinic visit with new imaging, the patient remained asymptomatic. The follow-up CT angiogram (CTA) demonstrated involution of the PAVM with thrombosis and narrowing of the distal embolized feeding vessel. There was no further enhancement of the PAVM and no new feeding vessels identified (Figure 5).

DISCUSSION

For simple or complex type PAVMs, transcatheter embolotherapy has become the treatment of choice with many different embolic platforms described.[2] This case report highlights the use of the novel MVP plug as a versatile (microvascular delivery and detachable) and highly effective (thrombogenic) option in treating PAVMs. ■

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John J. Park, MD, PhD
Division Chief, Interventional Radiology
City of Hope
National Comprehensive Cancer Center
Duarte, California
johnpark@coh.org
Disclosures: Speaker for Medtronic.

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Treatment of a Postbiopsy Hemorrhagic Pseudoaneurysm

BY MICHAEL COHN, MD, MS

Iatrogenic injuries from percutaneous renal biopsies (PRBs) are the most common (> 50%) cause of renal vascular lesions.[1,2] With the use of image guidance and automated biopsy needles, ≥ 99% of renal biopsies are diagnostic and complications after renal biopsy have decreased.[3,4] However, the success of the procedure is not only determined by obtaining adequate tissue for diagnosis, but also, if not more importantly, by the safety of the procedure. Although renal hematomas, arteriovenous fistula, or pseudoaneurysms can be self-limited complications after PRB, they may also become life threatening, requiring emergent intervention and resulting in increased hospital stay, treatment costs, and morbidity/mortality.[4-6] The reported incidence of renal pseudoaneurysms after PRBs is approximately 5%.[7] Superselective catheterization and embolization have become the primary treatment for symptomatic renal artery pseudoaneurysms. Embolization is safe, effective, and minimizes renal parenchymal infarction, but it is not without complication and risks.[8-11] This article describes a case in which the MVP™ microvascular plug (MVP; Medtronic) was utilized to quickly, accurately, and effectively treat a patient with a life-threatening hemorrhagic pseudoaneurysm, a complication that occurred after a PRB.

CASE STUDY

Presentation

A 56-year-old woman was referred to interventional radiology for a renal biopsy. She had a history of proteinuria and renal insufficiency due to diabetic nephropathy. Her past medical history included hypertension and type 2 diabetes mellitus. The coagulation profile, platelet count, and prothrombin time/international normalized ratio were within normal range. Her baseline hemoglobin was 10.3 g/dL, hematocrit was 31.5%, serum creatinine was 2.1 mg/dL, blood urea nitrogen (BUN) was 37 mg/dL, and glomerular filtration rate (GFR) was 29 mL/min/1.73 m^2.

The patient was placed in the prone position on the CT table. At the time of biopsy, her blood pressure was 150/92 mm Hg and heart rate was 78 bpm. CT biopsy of the right kidney was performed using an 18-gauge automated gun core needle with three sufficient cores obtained (Figure 1). The procedure was uneventful other than a large perinephric hematoma immediately following the biopsy (Figure 2). The patient was subsequently transferred to the recovery area for postprocedure monitoring with stable vital signs. Four hours after the procedure, the patient complained of severe right flank pain. Blood tests showed her hemoglobin and hematocrit dropped to 8.5 g/dL and 26%, respectively. Her blood pressure also dropped to 76/39 mm Hg. Interventional radiology was notified, and the patient was taken directly to the angiography suite.

Procedure Description

The patient's right common femoral artery was accessed under ultrasound guidance, and a 6-F sheath was inserted. A 5-F SOS catheter (AngioDynamics, Inc.) was inserted into the right renal artery origin, and an angiogram was obtained (Figure 3). Using a coaxial technique, a 2.7-F, 130-cm Progreat microcatheter (Terumo Interventional Systems) and a 0.018-inch, double-angle, 180-cm GT wire (Terumo Interventional Systems) was used to subselect the bleeding artery. After an angiogram was obtained to document the bleeding site (Figure 4), an MVP plug was advanced through the microcatheter and unsheathed in the bleeding artery. The position of the MVP plug was verified with digital subtraction angiography and deployed (Figure 5). A postembolization

angiogram showed complete occlusion of the embolized vessel (Figure 6). A pigtail catheter was then inserted into the aorta to the level of the renal arteries, and an aortic angiogram verified that there were no other accessory vessels supplying the affected kidney. The wires and catheters were subsequently removed and a closure device was placed. The patient was transferred to recovery for postprocedure monitoring.

Postprocedure Result

The following day, the patient was afebrile with stable blood pressure and vital signs. She still had some mild right-sided pain. The patient was discharged the following day. Repeat abdominal CT the day after the intervention showed the stable hematoma without active bleeding (Figure 7).

DISCUSSION

Independent predictors of postbiopsy bleeding are anemia, raised baseline BUN, renal insufficiency (serum creatinine > 1.2 mg/dL), poorly controlled hypertension (diastolic blood pressure > 90 mm Hg), and a prolonged bleeding time.[12-15] It has been shown that the risk of bleeding postprocedure actually increases with worsening levels of renal insufficiency, which can be worrisome because many patients undergoing biopsies have chronic renal insufficiency. Patients with advanced renal insufficiency (estimated GFR of < 40 mL/min/1.73 m^2) have a sixfold increased risk of severe bleeding postoperatively,[3,16] as was the case with our patient. Uremia is thought to play a role in platelet dysfunction.[17] Major events did not correlate with needle size or number of passes, although there was a nonsignificant trend for more hematomas with larger needles.[18]

Despite these predisposing risk factors, there is still no definitive way to predict which patients will develop a serious complication after biopsy.[19-21] Our patient developed a large perinephric hematoma despite not using antiplatelet agents and having normal prebiopsy bleeding and coagulation parameters. She did have multiple risk factors for bleeding, including an elevated BUN level, renal insufficiency (GFR, 29 mL/min/1.73 m^2), and hypertension. Although she developed a large perinephric hematoma after the biopsy, hematomas have been shown to be moderate to large in size in up to 50% of biopsies.[22,23] As seen in our case, severe flank pain in a patient with renal insufficiency after a PRB warrants careful follow-up. Further reduction of hemoglobin necessitated early evaluation with angiography, where a bleeding pseudoaneurysm was diagnosed and treated.[24]

Although most complications after a PRB are minor and resolve spontaneously, development of a clinically significant complication, such as hypotension, tachycardia, oliguria, gross hematuria, a significant drop in hemoglobin, as well as severe flank pain, has been reported in 7% to 15% of cases with the incidence of clinically significant hematomas ranging between 2% and 3%.[24-26] The clinical manifestations of a renal pseudoaneurysm vary from asymptomatic to nonspecific flank pain, hematuria, hypertension, and anemia.[8,27-30] However, most of the time, pseudoaneurysms that occur postbiopsy are

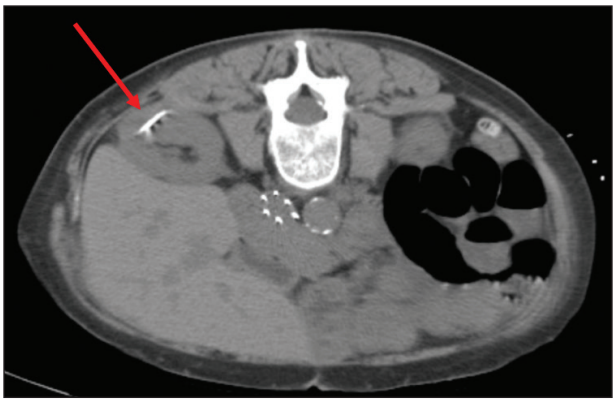

Figure 1. The biopsy needle in the kidney under CT guidance (arrow).

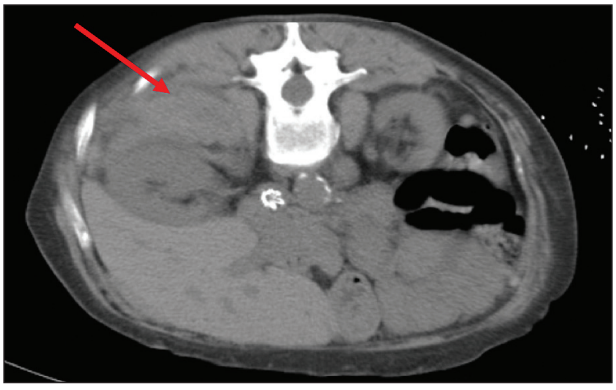

Figure 2. CT showing a large perinephric hematoma on the right (arrow).

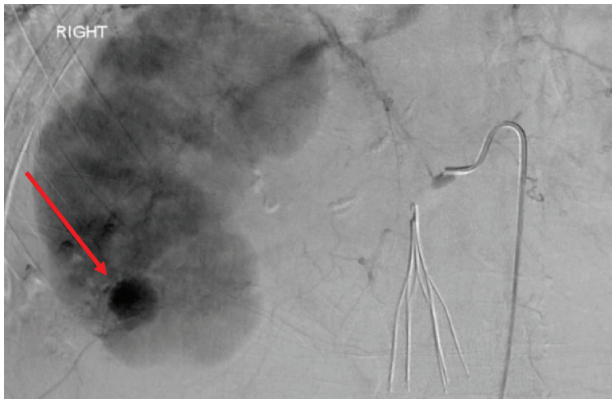

Figure 3. Angiogram showing the pseudoaneurysm in the lower pole of the right kidney (arrow).

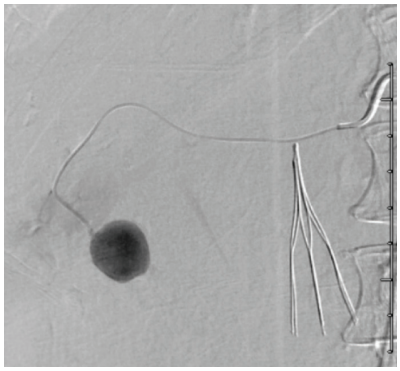

Figure 4. Angiogram showing the microcatheter in the vessel, which is supplying the pseudoaneurysm.

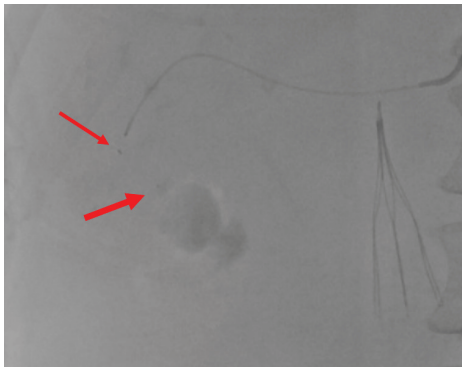

Figure 5. Deployed MVP™ plug. Note the proximal (thin arrow) and distal markers (thick arrow).

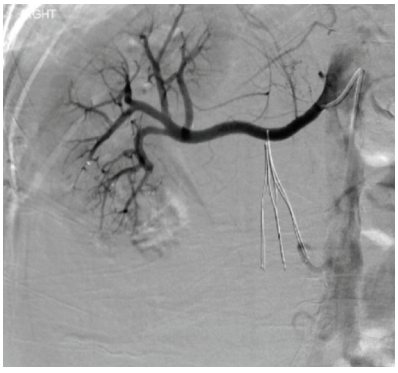

Figure 6. Angiogram showing that the pseudoaneurysm has been embolized and is no longer visualized. Due to the superselective embolization, virtually the entire renal parenchyma is spared.

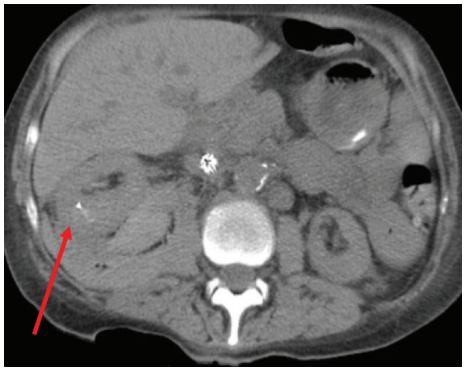

Figure 7. CT demonstrating the resorbing perinephric hematoma. Note that the MVP™ plug is in place (arrow) with no surrounding artifact.

asymptomatic, small, and spontaneously thrombose.[31] When they are symptomatic, a patient can present with a pulsatile mass in the pelvis, renal dysfunction secondary to compression of artery branches, shunting of blood, or, as in our patient, severe flank pain and hemorrhage from rupture.

Diagnosis is based on clinical suspicion and is critical to avoid the risk of rupture.[8-10,27] Although no consensus exists for the size at which a renal pseudoaneurysm should be treated in the asymptomatic patient, the risk of rupture correlates with the size of the pseudoaneurysm.[8,10] Early diagnosis and treatment is necessary to preserve the maximum amount of normal renal tissue, as renal ischemia persisting for ≥ 3 hours may result in severe tubular necrosis and renal dysfunction. Additionally, a delay in diagnosis may result in an increased deformity of the kidney due to a large hematoma, which can prevent superselective catheter placement, therefore necessitating a more proximal embolization and resulting in more parenchymal loss due to infarction.[32] Although these lesions can be managed surgically, embolization is preferred to minimize the loss of normal functioning renal parenchyma.

TREATMENT OPTIONS

The definitive diagnosis for pseudoaneurysm is made by selective renal arteriography, and the primary treatment is superselective embolization with coaxial catheter techniques. If embolization is not successful, surgical procedures are required, such as total or partial nephrectomy or ligation of the arterial branch.[33] An early and accurate diagnosis is the key to avoid unnecessary nephrectomy. If embolization is not available, surgery will be the only option and partial or total nephrectomy will inevitably be necessary, depending on the location of the bleeding artery.[34-36]

This is the first case to my knowledge of use of the MVP to treat a post-PRB life-threatening hemorrhage and associated pseudoaneurysm. In this case, the endovascular approach proved to be the right one, as the patient rapidly recovered. Various embolic agents including Gelfoam (Pfizer, Inc.), coils, polyvinyl alcohol (PVA), and N-butyl cyanoacrylate (NBCA) are available for the percutaneous treatment of renal vascular lesions; coils are most widely used. The use of a coaxial technique with microcatheters and microcoils enable precise localization, catheterization, and treatment of the bleeding arterial branches, limiting tissue loss to the traumatized vessel.[36-38] A disadvantage of coils is that adequate occlusion typically requires multiple coils, increasing the risk of misdeployment, cost, and valuable procedure time. Even more importantly, complete occlusion may not be adequately achieved.[10,36] PVA is biocompatible and inert, providing rapid occlusion of arteries. Although previously accepted as a permanent embolic agent, based on histologic examination, most large vessels containing PVA were incompletely occluded, with particles becoming embedded in the walls.[36,39,40]

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Unfortunately, PVA injection is difficult to control and inadvertent collateral embolization is not uncommon. Both Yamakado et al[41] and Parildar et al[42] have reported their experience with utilizing NBCA in renal arteries. In a report of five cases, Cantasdemir et al concluded that NBCA provides a permanent and accurate embolization in a cost-effective manner with advantages of low viscosity, enabling injection through microcatheters placed in distal, tortuous vessels and providing a rapid and complete thrombosis.[36,39,43]

NBCA and PVA are fast, cost-effective, and simple to use, but they have the potential risk of retrograde nontarget embolization, especially for small or slow flow lesions. NBCA has the added risk of gluing the catheter tip, causing inadvertent embolization and catheter retrieval time. Other reported complications include inadvertent occlusion of the neighboring vessel or even the main renal artery itself, causing postembolization syndrome, systemic hypertension, or renal functional impairment. Partial recanalization of any occluded branch can also produce stenosis, which has been reported to lead to hypertension.[2,36,38,44] Superselective embolization prevents many of these complications, therefore preserving renal function and eliminating the potential risk of nephrectomy.[2,36,37,44-47]

COURSE OF TREATMENT

The MVP plug is ideal in emergent cases that require quick and accurate superselective deployment. The MVP plug has excellent trackability, even in small vessels that are long and tortuous. It is composed of a nitinol frame with a polytetrafluoroethylene cover. It has good visibility due to radiopaque proximal and distal markers (Figure 8). The MVP plug can be unsheathed, and its position can be documented angiographically prior to its deployment. If the position of the MVP plug is not accurate, the device can be resheathed and repositioned, which makes misdeployment virtually impossible. This is key in renal vessels, as inadvertant misdeployment may frequently cause renal infarction and ultimately worsen renal function in a patient already with renal insufficiency.

Also, since one MVP plug is commonly sufficient for complete occlusion of the bleeding vessel, the procedure is expedited because the operator does not need to deploy multiple coils, does not have to wait until stasis is achieved, and additional angiography is not required between coil deployments. Because a single MVP plug is usually adequate, cost is also reduced. There is an added benefit of being able to visualize the embolized vessel and surrounding area clearly on postprocedure CT without the marked artifact commonly seen after coil embolization (Figure 7).

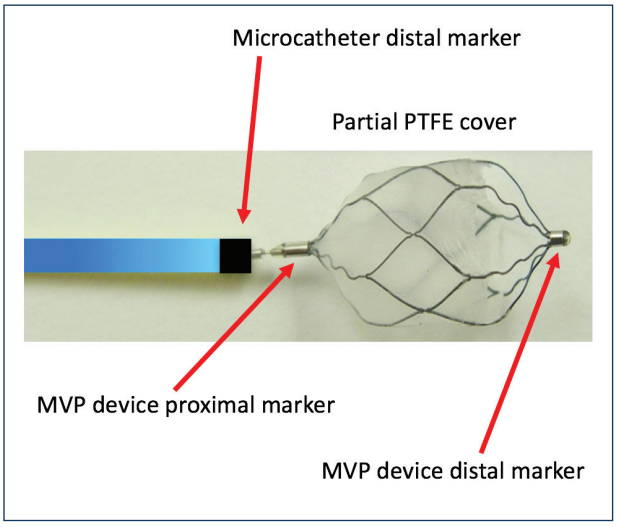

Figure 8. The MVP™ plug. Note the proximal and distal markers of the device. The device is unsheathed from the microcatheter after the position confirms the device is deployed. The device can be resheathed, repositioned, and redeployed if necessary.

CONCLUSION

Percutaneous transarterial embolization for the treatment of symptomatic renal vascular lesions following PRB is a very effective therapeutic technique. Superselective catheterization is the most important step, allowing preservation of maximum renal parenchyma and preventing additional loss of renal tissue by minimizing the occlusion of more proximal branches. Because the MVP plug is fast, accurate, and cost-effective, it is ideal for treating emergent hemorrhages associated with PRB as in this patient's case. ■

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Michael Cohn, MD, MS
Director of Vascular Services
Memorial Regional Hospital
Broward County, Florida
Assistant Professor
Florida Atlantic University Medical School
Boca Raton, Florida
Disclosures: Consultant for Medtronic, Sirtex Medical, and Argon Medical.

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Embolization of Bronchopulmonary Sequestration for Treatment of Massive Hemoptysis

BY ANDREW LEWIS, MD

CASE PRESENTATION

A 28-year-old man presented to the emergency department with acute massive hemoptysis. A chest CT angiogram demonstrated left lower lobe ground-glass pulmonary opacities compatible with hemorrhage and findings consistent with a left lower lobe bronchopulmonary sequestration (Figure 1A). Emergent embolization was requested by pulmonology.

PROCEDURAL DETAILS

A 5-F Cobra-2 catheter was advanced into the descending thoracic aorta and used to select the feeding artery to the bronchopulmonary sequestration. An angiogram was performed, confirming arterial supply to the bronchopulmonary sequestration within the medial left lower lobe with venous drainage via the left inferior pulmonary vein. A Lantern microcatheter (Penumbra, Inc.) was advanced into the distal feeding artery. Two branches of the distal feeding artery were successfully occluded with 5-mm MVP™ microvascular plugs (MVP-5Q; Medtronic). The Lantern microcatheter was exchanged for a 2.4-F Progreat microcatheter (Terumo Interventional Systems), and the feeding artery was subsequently embolized to its origin with multiple Concerto microcoils (Medtronic; sizes ranging from 4–8 mm). A postembolization angiogram demonstrated successful occlusion of the feeding artery (Figure 1B).

The patient was discharged from the hospital the next day with complete resolution of hemoptysis. Four months postprocedure, the patient reported no recurrent episodes of hemoptysis.

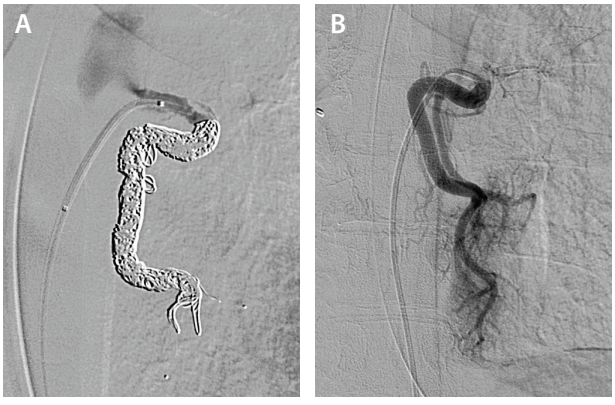

Figure 1. Angiograms of the left lower lobe bronchopulmonary sequestration before embolization (A) and after embolization using MVP-5Q™ plugs and Concerto microcoils (B).

DISCUSSION

In this case, the MVP-5Q plug was chosen for embolization of the distal branches because of its precise deployment and ability to perform a test injection to confirm successful occlusion prior to detachment. Concerto microcoils were chosen because of their packability, reliable detachment, and softness (no catheter kickback). ■

Andrew Lewis, MD
Interventional Radiologist
Radiology Specialists of Florida
Maitland, Florida
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