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Expand Your Confidence in Embolisation Treatment: Ruby Coil and POD

Experts discuss the Ruby coil and POD systems.

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Why do you use Ruby coils (Penumbra, Inc.) during your embolisation procedures?

Dr. Quaretti: I use Ruby coils because they offer specific features during coil delivery. These coils are used with routine high-flow microcatheters, provide large volume, softness, full control, and long lengths—Ruby coils give us the ability to address the special technical requirements in elective and emergent clinical situations. In addition, they offer advantages in terms of reduced time and number of coils to complete the procedure.

What are the benefits of the Ruby coils?

Dr. Moramarco: The Ruby platform is similar in size to the prior-generation 0.035-inch systems we currently use, but maintains high-flow microcatheter deliverability. The 0.020-inch diameter of Ruby (Figure 1) is compatible with 0.025- to 0.027-inch high-flow microcatheters. Furthermore, the softness and complex shape allows good packing and thus a stable permanent occlusion in vessels. In fact, the Ruby coils create a cross-sectional mechanical occlusion.

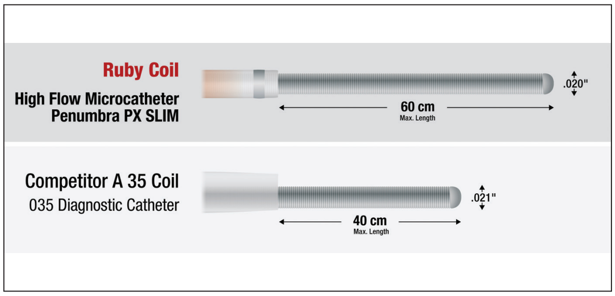

Figure 1. Size comparison of the Ruby coil and a 0.035-inch coil.

Why is it important to have good packing density?

Dr. Quaretti: The recent literature shows better long-term results when the volume of the aneurysm is filled with a high packing density of embolic material (Figure 2).[1,2] The large volume, long lengths, and tight packing of the Ruby coil enables users to achieve high packing densities. In the Penumbra ACE Study, a high average packing density of 28% was reported (Table 1).

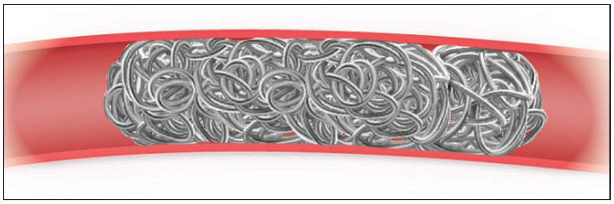

Figure 2. Illustration showing the high packing density of the Ruby coil.

TABLE 1. DATA FROM THE ACE STUDY ON RUBY COIL USE	
Aneurysms/Malformations	N = 40
Coils deployed per case (median)	6 coils
Fluoroscopy time (mean)	28 min
Packing density (mean)	28%
Peripheral Vessel Sacrifices	N = 28
Coils deployed per case (median)	2.5 coils

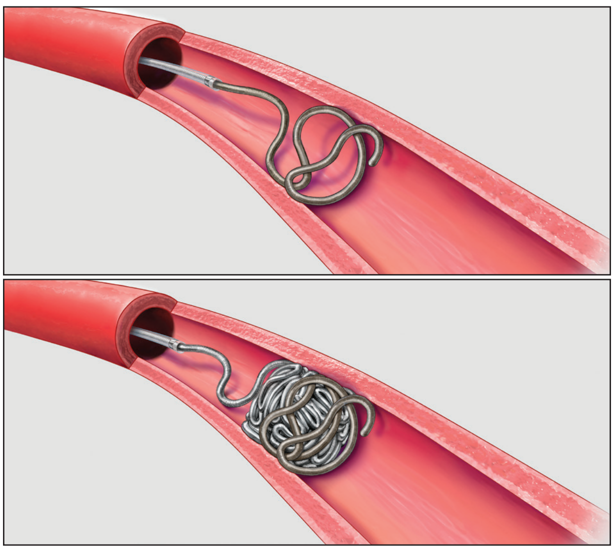

Figure 3. Illustration of the POD system in use.

What do you prefer to use to embolise a high-flow vessel?

Dr. Moramarco: Ruby detachable coils offer control, and their use is increasingly significant in many indications. However, there are some situations that are challenging

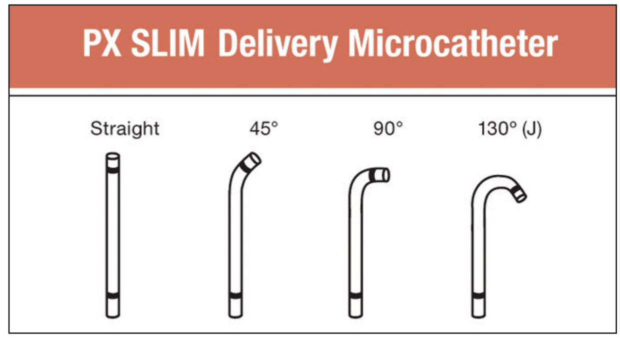

Figure 4. Tip shapes of the PX Slim microcatheter.

for all coils, such as high-flow anatomy. Penumbra, Inc. has solved this issue with a very elegant engineering design of its Penumbra Occlusion Device (POD) (Figure 3). By adding new technology to the distal anchoring segment, the POD immediately catches in the vessel (Figure 3).

What other devices are helpful during your daily embolisation procedures?

Dr. Moramarco: The angled tips of the Penumbra microcatheter help the coil start to form faster in the vessel by deploying the coil toward the vessel and can be used to optimize the utility of Ruby coils. The high-flow 0.025-inch PX Slim microcatheter is available with four different tips (Figure 4). In the United States, Penumbra has also recently launched a new microcatheter, Lantern, which is highly visible and provides even greater utility in peripheral procedures. Lantern is a low-profile, high-flow microcatheter.

1. Teigen C, Moyle H, Patel RS, et al. Experience using large volume detachable coils in the peripheral vasculature: preliminary results from the ACE multicenter study. J Vasc Intervent Radiol. 2015;26(2 suppl):S24.
2. Yasumoto T, Osuga K, Yamamoto H, et al. Long-term outcomes of coil packing for visceral aneurysms: correlation between packing density and incidence of coil compaction or recanalization. J Vasc Interv Radiol. 2013;24:1798-1807.

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CASE REPORT

A woman in her early 20s with a history of sickle cell disease was admitted to the hospital with splenomegaly (Figure 1). A CT scan showed an angulated celiac trunk and a tortuous splenic artery (Figure 2). Surgeons discussed a troncular splenic artery embolisation in order to minimize blood loss during splenectomy.

Because of the access and tortuosity of the splenic artery, coil embolisation was chosen instead of plug embolisation. Selective angiography and subangiography were performed through the celiac axis and splenic artery before embolisation. Opacification was a bit low because of the substantial flow in the splenic artery (Figure 3).

The first device deployed was a POD8 device (8 mm X 50 cm) (Figure 4). We used this coil as an anchor with a precise placement at the junction with left gastroepi-

Figure 1. Abdominal CT showing splenomegaly.

Figure 2. Abdominal CT (vascular reconstruction) showing an angulated celiac trunk and a tortuous splenic artery.

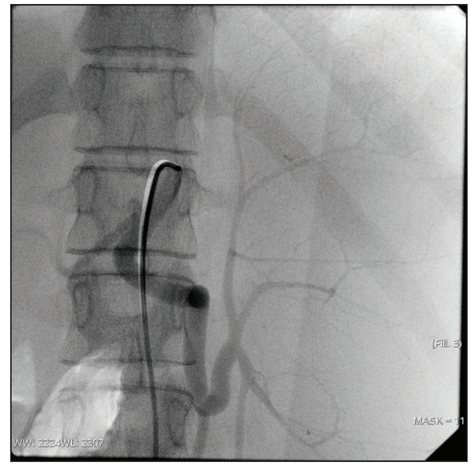

Figure 3. Angiogram demonstrating an angulated celiac trunk and a tortuous splenic artery.

Figure 4. Angiogram after complete deployment of the POD8 device (8 mm X 50 cm) via the microcatheter.

Figure 5. Angiogram during deployment of an 8-mm X 30-cm soft Ruby coil.

Figure 6. Control angiogram of the splenic artery demonstrates the complete occlusion after complete deployment of a 6-mm X 30-cm Ruby coil.

ploic artery, followed by two soft Ruby coils (8 mm and 6 mm X 30 cm) to achieve tight packing (Figure 5).

Complete occlusion of the splenic artery was achieved, as seen on final angiography at 3 minutes postdeployment (Figure 6). This case demonstrates that tight packing and complete occlusion can be obtained in a large vessel after a quick and safe embolisation procedure.

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Ruby coils are widely used at San Camillo Hospital, especially for embolisation of visceral aneurysms, as well as in secondary procedures after endovascular aneurysm repair and thoracic endovascular aneurysm repair (TEVAR) to manage an endoleak. Their softness allows them to quickly take the shape of the targeted anatomy. Furthermore, the wide range of available diameters and lengths can fill massive lesions, saving time and cost.

With the introduction of the chimney technique, the occurrence of type I endoleak after TEVAR is progressively increasing because of the gutters. We usually reserve this technique for emergent cases; therefore, the early detection and treatment of a high-flow endoleak

Figure 1. CT scan showing both the endoleak and the gutter between the parallel grafts.

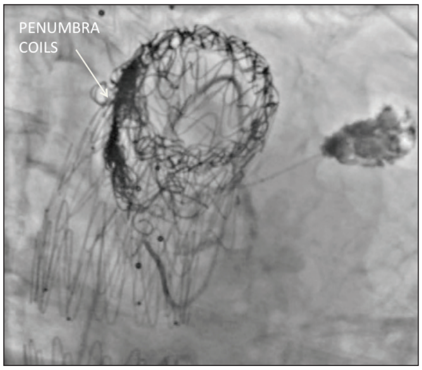


Figure 2. Angiogram showing three Ruby coils deployed in the short gutter.

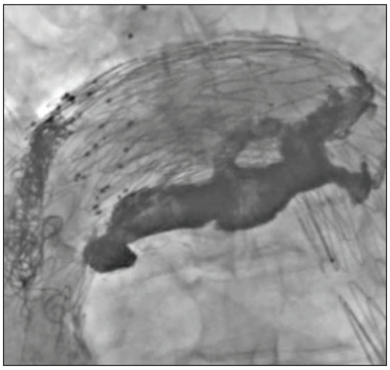


Figure 3. Final angiogram.

may be critical for clinical success. This report describes early embolisation of a gutter endoleak after TEVAR.

CASE REPORT

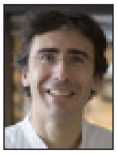
A man in his early 70s previously treated with carotid-carotid-subclavian bypass and TEVAR for aortic arch aneurysm presented in our department with hemoptysis. CT demonstrated a large proximal type I endoleak very close to the ostium of the innominate artery and still perfusing the aneurysm, without any migration of the stent graft. An open conversion was discarded because of the high comorbidity, and an endovascular correction with a single chimney graft in the innominate artery and proximal aortic extension cuff was proposed. The chimney procedure was uneventful. CT performed 24 hours later showed persistent proximal perfusion of the aneurysm through the channels between the chimney and the aortic graft (Figure 1).

The patient promptly underwent embolisation of the gutter endoleak. The procedure was performed under local anesthesia using a percutaneous right femoral approach. The gutter between the chimney graft and aortic extension was engaged with a 5-F Simmons 1 catheter, and the endoleak was catheterized using a Progreat® microcatheter (Terumo Interventional Systems). The core of the endoleak was filled with a liquid polymer, and the gutter was occluded with three 12-mm X 40-cm Ruby coils (Figure 2).

The Ruby coils were easily delivered through the microcatheter at a 180° angle. The gutter was completely occluded as demonstrated by the final angiogram that showed the complete exclusion of the aneurysm (Figure 3).

DISCUSSION

In this patient, the exceptional control and softness of the coils allowed for a precise detachment within the short channel between the parallel grafts. The choice of a liquid polymer to fill the sac and coils to occlude the channel is an effective strategy. In fact, using a liquid agent with the ability to spread through the grooves of the thrombus is preferred. On the other hand, selective embolisation of a small channel with virtually no risk of migration could only be achieved with the use of soft coils and a controlled deployment system, such as the Ruby system.



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In my practice, the Penumbra Occlusion Device (POD) allows us to selectively and safely embolize targeted segments of arteries by packing a sufficient quantity of soft platinum coils to achieve occlusion in a fashion similar to existing bare-platinum embolisation coils. The POD system consists of three components: a coil implant attached to a detachment pusher and a detachment handle. The coil implant of the POD is designed with a unique distal tip, which is stiffer and larger in diameter and is followed by a softer packing segment. Thus, the deployment of this distal end serves as an anchor, securing the coil construct. Advantages of such device are: (1) only a delivery

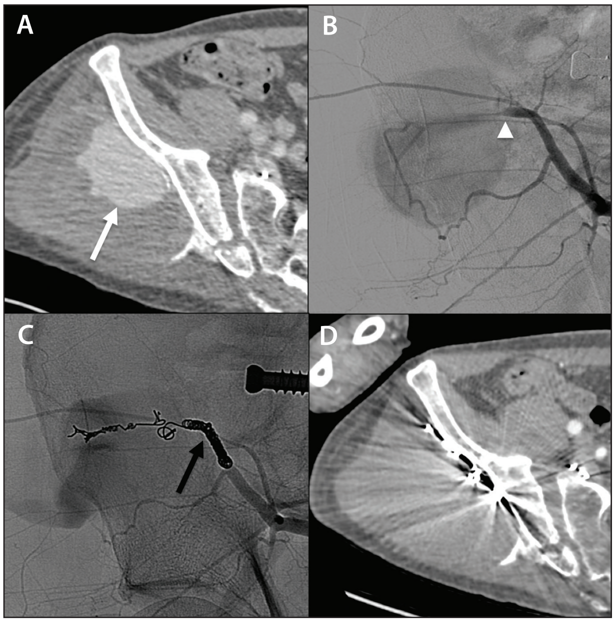

Figure 1. CT showing a 6-cm aneurysm arising from the right posterior gluteal artery (arrow) (A). Angiogram showing a 4-F Cobra C2 angiographic catheter selecting the right superior gluteal artery (arrowhead) (B). Angiogram after embolisation showing no contrast flow into the sac (arrow) (C). CT at 3-month follow-up showing that the false aneurysm remained completely occluded (D).

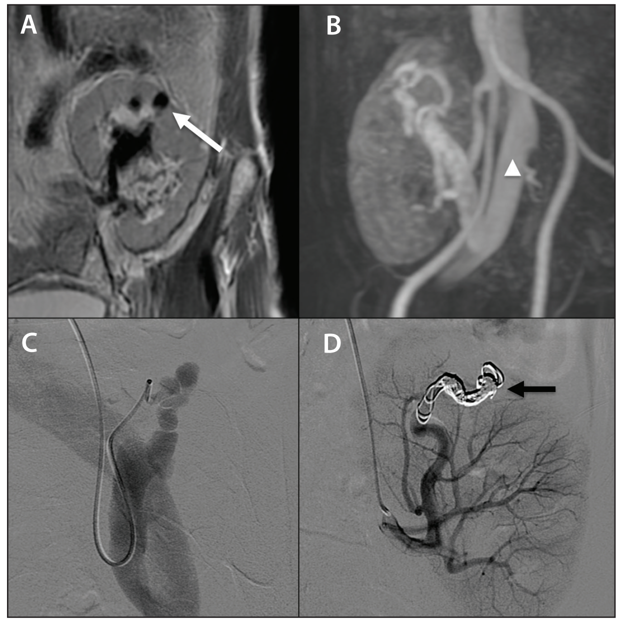

Figure 2. MRI showing a 1-cm AVF (arrow) (A). Large dilation of the renal vein (arrowhead) (B). The microcatheter was introduced into the AVF in order to preserve renal branches (C). Embolisation performed with one POD8 (arrow) (D).

0.025-inch microcather is required; (2) the coil may be removed and replaced until detachment; and (3) a single device may be used to obtain adequate packing. The following cases highlight the strength of the POD to complete trunk occlusion in various arteries.

CASE REPORT 1

A man in his early 60s with a medical history of pelvic trauma and osteosynthesis 3 months prior presented with symptoms of a pulsatile pelvic mass and pain. He was admitted to our institution with a 6-cm aneurysm arising from the right posterior gluteal artery approximately 3 to 4 cm distal to its origin (Figure 1A).

A 4-F sheath was inserted into the left femoral artery, and a 4-F Cobra C2 angiographic catheter was used to select the right superior gluteal artery (Figure 1B). Next, a PX Slim microcatheter was used to select the feeding arteries over a 0.018-inch guidewire. A distal embolisation was performed using a 3-mm X 15-cm soft Ruby coil. The microcatheter was replaced and then advanced into the proximal portion of the trunk of the gluteal artery. Embolisation was performed by placing one POD4 (4 mm X 30 cm) in < 5 minutes. Multiple angiograms were obtained after embolisation showing no contrast flow into the sac (Figure 1C). There were no procedural complications. At 3-month follow-up, the aneurysm remained completely occluded (Figure 1D).

DISCUSSION

Since using the POD technology, I have noticed a significant decrease in complexity and procedure time for embolisation procedures performed into the trunk of arteries. One main advantage of the POD is that complete occlusion of an artery can be achieved, much like a plug, but using only a high-flow microcatheter. However, some technical points must be considered. An adequate selection of the POD size is important to secure the delivery and allow for a more compact coil mass. In fact, the diameter of the POD must closely match the diameter of the vessel to avoid migration during coil deployment. Three to four loops of the distal segment seem sufficient to allow secure delivery of the POD at the desired point. Moreover, as the anchor zone transitions into a softer and smaller-diameter mass, adequate packing must be performed. During deployment of this section, forward loading the delivery microcatheter within the anchor seems to allow the softer coil to bury itself inside the frame and then limit the length of packing. This has resulted in a more compact coil mass with the deployment of this single device compared to other techniques.

CASE REPORT 2

A woman in her late 50s with a medical history of renal transplantation presented with a large acquired arteriovenous fistula (AVF) into the graft. Progressive renal function impairment was observed. MRI showed a 1-cm AVF that had been increasing in size (Figure 2A). A large dilation of the renal vein was observed as a consequence of the high flow within the AVF (Figure 2B). The patient was admitted to our institution for embolisation.

A 4-F sheath was inserted into the right femoral artery, and a Cobra C2 angiographic catheter was used to select the renal artery. Next, a PX Slim microcatheter was used to select the AVF over a 0.018-inch wire, which was then advanced into the AVF. The artery was tortuous; however, the flexibility of the PX Slim microcatheter easily negotiated the loops. This allowed for a stable construct before embolisation (Figure 2C). Embolisation was performed with placement of one POD8 (8 mm X 60 cm) in < 5 minutes (Figure 2D).

The flow into the vein decreased, and the renal parenchyma was well visualized. Multiple angiograms were then obtained, which documented complete embolisation with no contrast flow remaining into the AVF. There were no procedural complications. At 3-month follow-up, the AVF remained completely occluded. Normal renal function was recovered.

DISCUSSION

In order to secure the delivery, we use a catheter allowing adequate stabilization of the microcatheter and push of the POD system. This is important because the detachment pusher remains stiff even in 0.020 inches. Although it was not essential in this specific case, a shepherd hook or Simmons catheter seems adequate to achieve proximal embolisation in splenic, mesenteric, or renal arteries.

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CASE REPORT

A woman in her early 40s suffering from mild acute pancreatitis underwent an abdominal ultrasound examination, which found a 2.6-cm arterial structure in the upper abdomen near the pancreas. Consecutively, CT angiography (CTA) of the abdomen was performed to evaluate the suspicious aneurysm/pseudoaneurysm more in detail.

CT examination showed a 2.6- X 1.8-cm aneurysmatic arterial structure near to the pancreatic head (Figure 1). The pancreas itself showed no calcifications as a possible sign of chronic pancreatitis, and there were no signs of necrotizing pancreatitis. The celiac trunk was occluded; the hepatic artery was perfused via the gastroduodenal artery (Figure 2). Based on the CT images, the origin of the aneurysm was not completely clear but appeared to be a very small side branch of the superior mesenteric artery (SMA) with a short, thin neck. The aneurysm drained into a (doubled) splenic artery.

The patient's history, present symptoms, and results of imaging were discussed in an interdisciplinary board of interventional radiologists, vascular surgeons, and internal medicine physicians. Due to the size of the aneurysm, treatment was indicated, but surgery was not an option due to the acute pancreatitis. The exact pathophysiologic cause of the aneurysm was not completely clear; nevertheless, the pancreatitis with a consecutive pseudoaneurysm was rated as the more likely variant. The treatment plan was to embolise the aneurysm, which was minimally invasive with a small probability of complications due to the short but thin neck and the doubled splenic artery, which made a splenic infarct relatively unlikely.

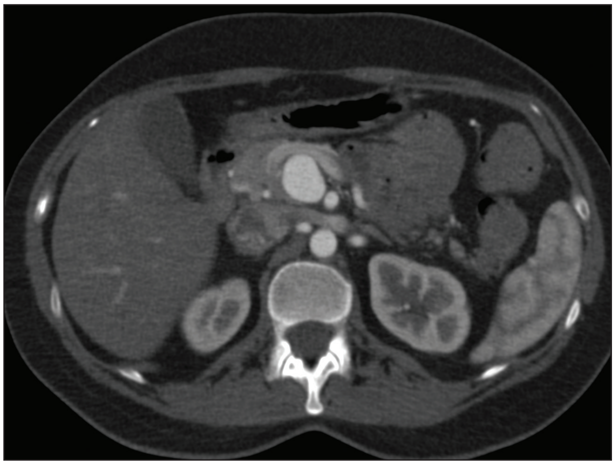

Figure 1. Axial CT image showing the aneurysm near the head of the pancreas and the SMA.

Under local anesthesia, the right common femoral artery was punctured and a short 6-F sheath was inserted. Angiography of the SMA was performed using a 5-F sidewinder catheter (Figure 3). The results of the CTA were confirmed.

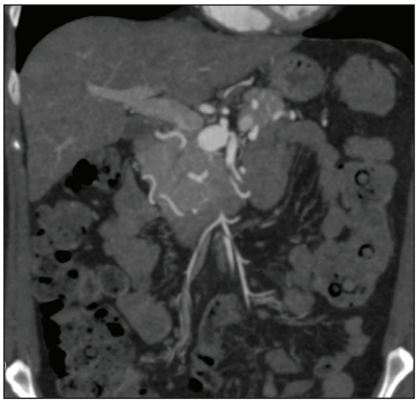

Figure 2. Thin-slab coronal maximum intensity projection CTA.

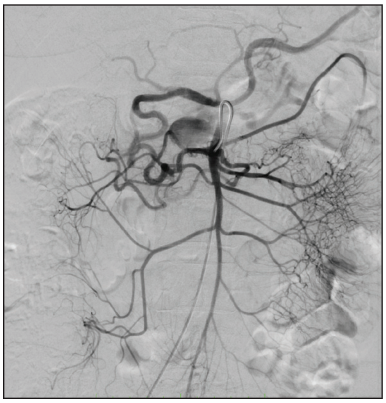

Figure 3. Power injector series of the SMA.

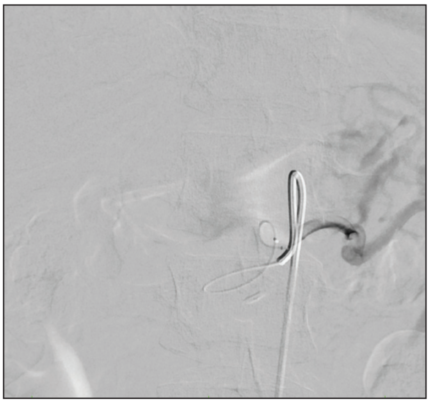

Figure 4. PX Slim microcatheter used in the draining (doubled) splenic artery.

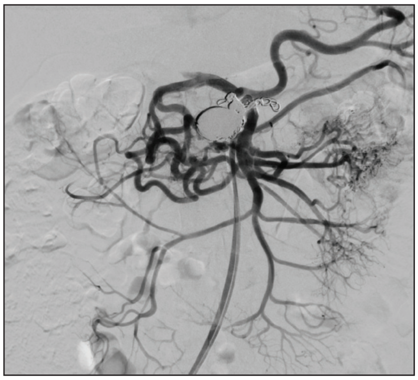

Figure 5. Angiography of the SMA after exclusion of the aneurysm.

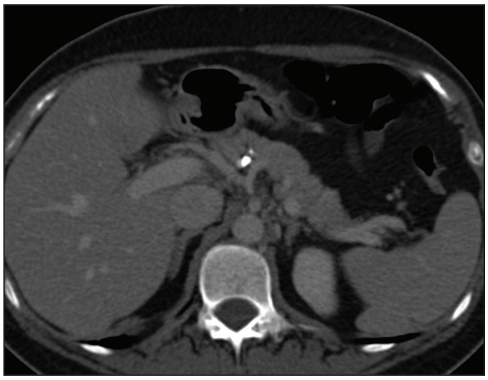

Figure 6. CT performed on postprocedure day 1 showing a regular perfused spleen, as well as a regular splenic artery and hepatic artery.

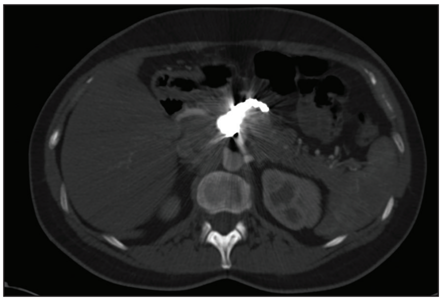

Figure 7. CTA of the abdomen showing the coils in the completely excluded aneurysm and in the outgoing accessory splenic artery.

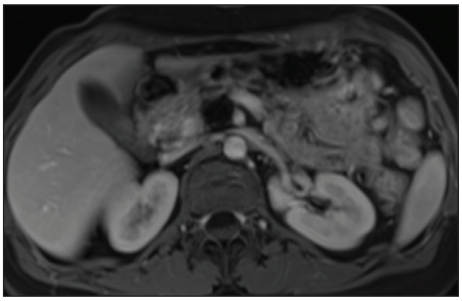

Figure 8. MRI of the upper abdomen at 3-month follow-up showing a metal artifact of the coils with regular perfusion of the SMA.

With a 90° angled Penumbra PX Slim Microcatheter and a hydrophilic 0.014-inch guidewire, the aneurysm as well as the draining artery were cannulated (Figure 4). The embolisation procedure was started with coil occlusion of the outgoing splenic artery. The microcatheter was retracted into the aneurysm, and the aneurysm was occluded with multiple standard Ruby coils followed by soft Ruby coils. Altogether, 17 Ruby coils with a length up to 60 cm and a diameter between 8 and 32 mm were placed. The final result showed a complete exclusion of the aneurysm with a regular perfusion of the SMA (Figure 5).

The next day, a control CT showed a complete exclusion of the aneurysm without any complications and no splenic infarction (Figures 6 and 7). The patient was discharged the following day in an excellent clinical condition. Three months later, there were no clinical signs of pancreatitis, an MRI of the upper abdomen did not show any complications, the liver and the SMA were regular, and the aneurysm was excluded (Figure 8).

DISCUSSION

In my opinion, the following are crucial in order to solve complex embolisation cases successfully without complications: High-quality CTA prior to the procedure is crucial in order to evaluate different treatment options and to establish a detailed step-by-step approach to the procedure. Moreover, the appropriate material including sheaths, macro- and microcatheters, as well as wires, and coils should be prepared.

The Penumbra Microcatheter is an excellent hydrophilic and pressure-resistant microcatheter with two markers for a successful and secure coil placement. When aneurysms are treated by coil placement, two markers are a definitive "must-have," because the distal marker is not visible after placement of a few coils. The second marker remains outside of the aneurysm, which allows release of the coils in the optimal position.

The 45° or 90° angled variant of the microcatheter is helpful to get the tip of a coil "away" from the aneurysm during coil placement. Additionally, the angled tip allows some kind of steerability of the microcatheter, which can be helpful to enter small side branches.

Using the large-volume, detachable Ruby coils, the total number of coils for complete aneurysm occlusion with a high packing density can be reduced dramatically compared to standard coils, which also leads to a reduced radiation dose and procedure length.

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CASE REPORT

A woman in her early 40s presented with a very tortuous splenic artery with two aneurysms. The first was a 1-cm aneurysm located at the middle third of the splenic artery, and the second was a 2-cm saccular aneurysm located at the hilum. The patient arrived at our department after a failed laparoscopic surgery treatment of the aneurysm at the hilum. The patient presented with hostile anatomy due to an extremely tortuous splenic artery; for this reason, the embolisation of the hilum was very difficult (Figure 1).

A 6-F sheath was placed in the humeral artery. With a neuroradiologic guide catheter, we were able to cross the first tortuous part of splenic artery. This catheter allowed for a stable construct with satisfying support and stability before coil embolisation. Now it was possible to place the 45° PX Slim microcatheter inside the aneurysm at the hilum, over a 0.014-inch Hi-Torque Pilot® 200 guidewire (Abbott Vascular). Multiple Ruby coils were detached within the aneurysm. Embolisation was performed with placement of a total of five 20-mm X 60-cm soft Ruby coils, with a complete occlusion and a packing density > 30% (Figure 2).

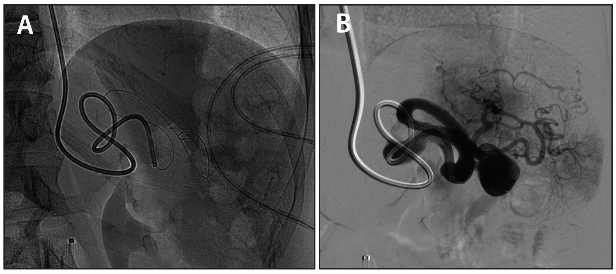


Figure 1. High tortuosity and splenic artery access with a neuroradiologic guide catheter (A). Angiogram of the splenic artery before embolisation (B).

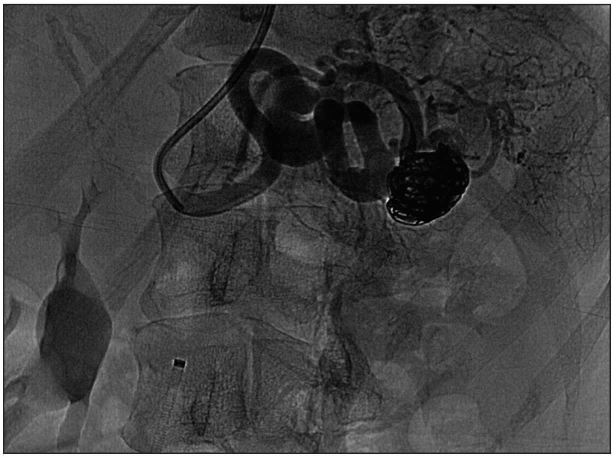
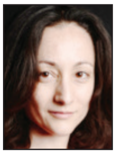


Figure 2. Postembolisation angiogram showing complete occlusion.

In my opinion, the volume advantage and softness of the Ruby coils made it possible to use fewer detachable coils while achieving tight packing. Thanks to the good coil packing density into the aneurysm and the embolisation of the distal flow into the splenic artery and hilum of the spleen, it was possible to avoid the aneurysm recanalization.

DISCUSSION

Splenic aneurysms are often associated with an extremely tortuous artery. In fact, this procedure is complex and commonly leads to technical failure. The Ruby coil is a good solution for treatment of complex cases with difficult and tortuous anatomy. In my experience, the Ruby coils offer precise, accurate, fast, and easy deployment and excellent pushability. The softness and complex shape allows good packing and stable permanent occlusion. The minimally invasive approach has the potential to positively impact our procedure with fewer complications posttreatment, short hospitalization, and a short time to return to work for the patient.



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CASE REPORT

A woman in her early 50s with fatigue and breathlessness on minor physical exertion underwent a chest X-ray. A round shadow at the base of the left lung prompted the referral to request a CT angiogram (CTA), which revealed a large, 1.9-cm pulmonary arteriovenous (AV) fistula at the left lower lobe abutting the pleura (Figure 1).

Starting with a long 7-F sheath, a measuring pigtail catheter was advanced at the left pulmonary artery. Angiograms and DynaCT (Siemens AG) were obtained to better delineate the anatomy and the speed of flow of the AV flow shunt (Figure 2). The ideal location to start the embolisation was further correlated with CT for accurate measurement. Axial CTA measurement at the selected point was 8 mm; thus, an 8-mm POD (60 cm) was utilized. As this was a very high-flowing shunt, upon delivery of the anchoring part of the POD, the position was evaluated with subsequent angiograms to confirm appropriate anchoring and accuracy of positioning (Figure 3A). The remaining 60 cm of the coil was deployed, providing satisfactory scaffolding (Figure 3B). Within the scaffolding, an 8-mm X 60-cm soft Ruby coil was deployed to fill any empty gaps within the existing scaffolding, providing a solid appearance. Completion angiogram confirmed complete isolation of the AV fistula from circulation (Figure 4). At 4-month follow-up, CTA showed complete resolution of the AV fistula (Figure 5).

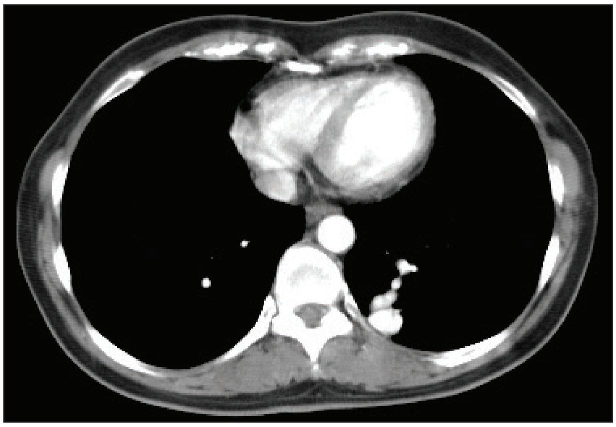

Figure 1. Pre-embolisation CTA.

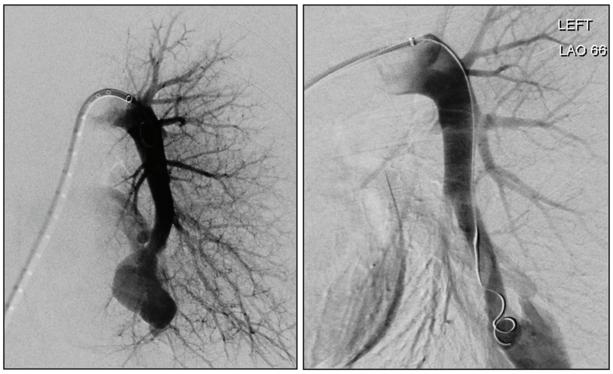

Figure 2. Fast-flowing AV pulmonary shunt.

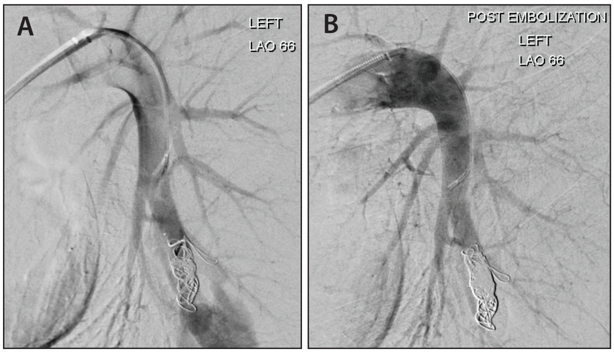

Figure 3. Angiogram confirming the stability and accuracy of the POD device (A). Deployment of the remaining 60-cm coil of the POD device (B).

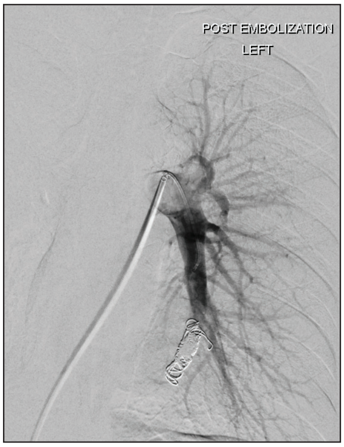

Figure 4. Completion angiogram on a different projection.

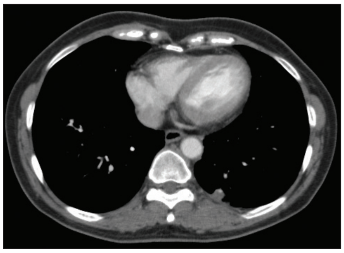

Figure 5. CTA at 4 months postembolisation.

DISCUSSION

The great advantage of the POD is that, upon accurate size measurements, it can provide a very precise and stable anchoring, even within a very high-flow system. Furthermore, the POD continues as a very long coil, thus speeding the embolisation significantly. There is extra reassurance because the POD is retrievable. The soft Ruby coil provides a solid packing and fills any residual space. ■

The opinions and clinical experiences presented herein are for informational purposes only. The results may not be predictive for all patients. Individual results may vary depending on a variety of patient-specific attributes.