

The MVP™ Microvascular Plug

A valuable addition to the armamentarium for peripheral embolization.

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Today, interventional radiology is a field being driven forward by advances in embolization. Embolization continues to evolve into an effective treatment for benign and malignant tumors, traumatic vascular injury, vascular malformations, and countless other potential indications. In some settings, liquid embolization or particulate embolization with either bland or drug-loaded microspheres is preferred, but for many others, mechanical embolization is appropriate.

Historically, coils have been used for mechanical embolization. When treating patients with coils, it is known that the size, shape, number, density, and characteristics of the coils all contribute to successful vascular occlusion.^{1,2} Interventionists, however, are well aware that it often requires multiple coils to achieve successful embolization, which can be time consuming. As the economics of both material cost and physician time become increasingly significant, the inherent inefficiencies of placing a large number of either pushable or detachable coils become apparent. The introduction of vascular plugs, highlighted initially by the Amplatzer vascular plug (St. Jude Medical, Inc.),³ was advanced in large part to address the need for complete vascular occlusion in less time and using fewer devices.

In recent years, there has been much innovation in the field of vascular plugs. The MVP™ microvascular

plug (Medtronic) was introduced in 2013 and is indicated to obstruct or reduce the rate of blood flow in the peripheral vasculature (Figure 1). The cage design is composed of nitinol covered by a polytetrafluoroethylene (PTFE) membrane at its proximal portion.⁴ There is a single radiopaque marker at both the proximal and distal tips of the nitinol exoskeleton.⁵ The PTFE covering affords the opportunity for a truly mechanical occlusion that does not rely exclusively on thrombosis to achieve the desired endpoint. The plug is connected to a 0.018-inch nitinol pusher wire for 3- and 5-mm sizes and a 0.027-inch nitinol pusher wire for 7- and 9-mm sizes. The device is deployed by withdrawing the delivery catheter and then rotating the pusher wire in a counter-clockwise direction. One benefit of this plug is that it can be easily resheathed and redeployed if repositioning is necessary prior to its release.

There are currently four models of the MVP™ plug that are available, with nominal diameters of 3, 5, 7, and 9 mm. These four models are indicated for placement in vessels with diameters of 1.5 to 3 mm, 3 to 5 mm, 5 to 7 mm, and 7 to 9 mm, respectively. Importantly, the smaller models can be introduced through microcatheters with 0.021- and 0.027-inch inner diameters, whereas the larger sizes can be placed through standard 4- and 5-F angiographic catheters. The initial published experience with the MVP™ plug has been positive,

highlighting its deliverability and ability to achieve vascular occlusion.⁴⁻⁶ The following brief case reports demonstrate the success and potential use of the MVP™ plug for several different indications.

CASE 1

A 76-year-old man with an abdominal aortic aneurysm underwent endovascular aneurysm repair in 2006. Surveillance CT identified a type I endoleak in 2008, and this was sub-

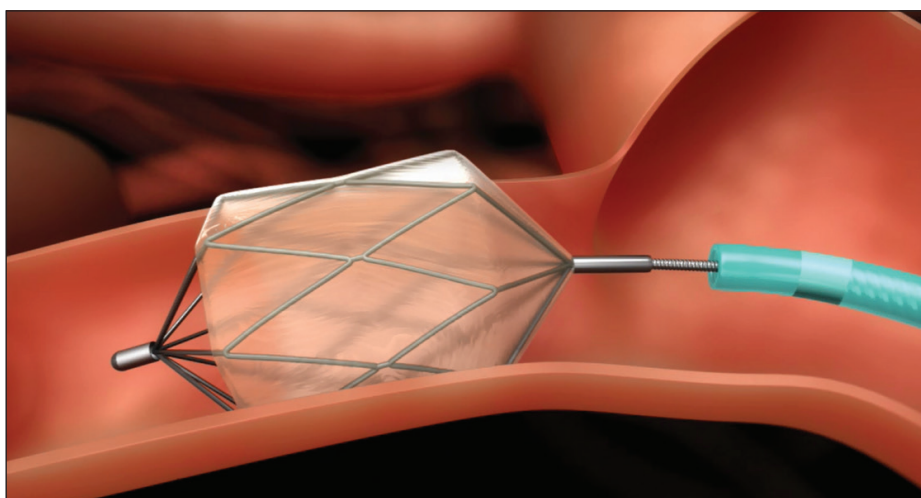


Figure 1. The MVP™ plug with its nitinol cage design and proximal PTFE membrane.

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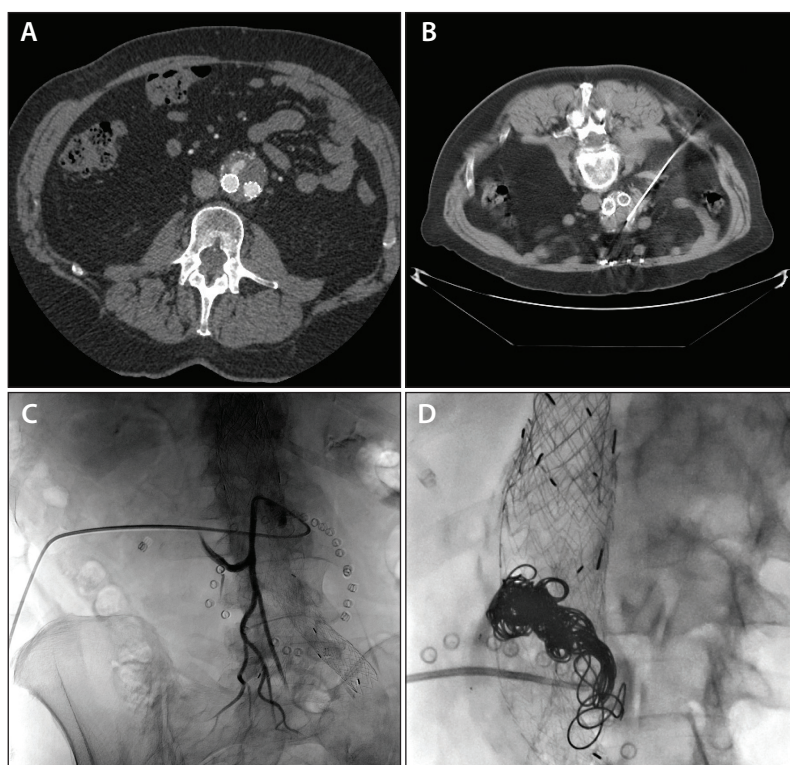


Figure 2. A 76-year-old man with a type II endoleak after endovascular repair of an abdominal aortic aneurysm. The endoleak is shown on contrast-enhanced CT of the abdomen (A). Translumbar embolization was initially performed under CT guidance (B) and was continued under fluoroscopy, enabling selective catheterization of the inferior mesenteric artery (C) and embolization of the inferior mesenteric artery and the aneurysm sac (D).

sequently repaired with an aortic extension cuff. He has since been regularly followed with imaging, which demonstrated sac enlargement secondary to a type II endoleak with inflow arising from the inferior mesenteric artery (Figure 2A). Given these findings, he was referred for embolization as treatment for this type II endoleak.⁷

The embolization procedure utilized CT guidance for needle access into the aneurysm sac. With the patient in the prone position, a translumbar approach was used to place an 18-g Chiba biopsy needle (Cook Medical) into the posterolateral aspect of the native aneurysm sac (Figure 2B).⁸ Once the tip of the needle was within the sac and positioned directly posterior to the origin of the inferior mesenteric artery, the needle was exchanged over a stiff guidewire for a 25-cm, 5-F vascular sheath. The patient was then transferred in the prone position to the angiography suite. Once the patient was comfortably positioned, a 5-F Berenstein catheter (Boston Scientific Corporation) and a 0.035-inch Glidewire (Terumo Interventional Systems) were used to selectively catheterize the inferior mesenteric

artery (Figure 2C). A Renegade Hi-Flo microcatheter (Boston Scientific Corporation) was then advanced in a coaxial fashion into the proximal inferior mesenteric artery, and an MVP-5Q plug (Medtronic) was deployed, causing instant cessation of inflow into the aneurysm sac. The microcatheter was then removed, and the Berenstein catheter was pulled back into the aneurysm sac. After multiple unsuccessful attempts at catheterizing the lumbar artery providing outflow, the aneurysm sac near the ostium of the lumbar artery was embolized with multiple detachable coils (Retracta detachable coils, Cook Medical) and pushable coils (Nester and Tornado embolization coils, Cook Medical) deployed through the Berenstein catheter. The procedure was stopped once the outflow from the aneurysm sac was no longer visualized on aortography (Figure 2D) and blood could no longer be easily aspirated via the catheter.

Discussion

When treating patients with type II endoleaks, it is ideal to address the inflow and outflow vessels, as well as the space within the sac serving as the

low-pressure nidus for flow.^{9,10} The need to navigate a catheter through the aneurysm sac into the inflow and/or outflow vessels can be challenging. As a result, these can be time-consuming procedures potentially requiring multiple embolic agents. Once a target vessel is catheterized, it is appealing to have one device that can provide rapid occlusion, and in this particular case, the MVP™ plug served that role. Besides the inherent savings in time and radiation exposure, the use of the MVP™ plug prevented any recoil or push back during coil deployment that would have cost us our selective catheter access.

CASE 2

A 33-year-old man presented to the emergency department after being struck by a truck as a pedestrian. Upon arrival, the patient's vitals were stable, and a CT scan of his abdomen and pelvis was performed. The CT demonstrated a grade III splenic laceration with a small perisplenic hematoma. The emergency department then consulted our service for angiography and embolization.



Figure 3. A 33-year-old man presenting with a grade III splenic laceration after trauma. Splenic angiography showed no arterial injury (A), and proximal embolization was performed. Follow-up angiography showed that it took several minutes after deployment of the MVP™ plug to achieve proximal occlusion of the splenic artery (B, C).

After gaining access through the right common femoral artery, the celiac axis was catheterized with a VS2 catheter (Cook Medical). Multiple celiac arteriograms in different projections were obtained, showing no evidence of active extravasation in the spleen (Figure 3A). Therefore, the decision was made to proceed with proximal splenic embolization, given its success at reducing the risk of delayed rupture.^{10,11} The VS2 catheter was exchanged for a 4-F Glidecath cobra catheter (Terumo Interventional Systems), and this catheter was advanced to the transverse portion of the proximal splenic artery. An MVP-7Q plug was then deployed through the Glidecath catheter. The initial images obtained after deployment of the plug demonstrated markedly decreased (but persistent) flow through the splenic artery (Figure 3B). Images obtained 2 minutes after deployment of the plug demonstrated complete embolization of the splenic artery with reflux of contrast into the left gastric artery (Figure 3C).

Discussion

Several plugs and coils are available for a proximal splenic artery embolization in the setting of trauma. The choice often depends on the tortuosity of the vessel because that will often dictate which delivery catheter or sheath can track over a wire toward the site selected for embolization, which will in turn affect the embolic options. Microcatheters may be required for

many patients, which means that detachable and/or pushable microcoils would be utilized for embolization. For patients in whom standard angiographic catheters can be advanced into a relatively straight portion of the splenic artery, plugs become an attractive option, as occlusion can be achieved with fewer devices.¹² The MVP™ plug in particular is trackable through traditionally tortuous anatomy and can effectively be used to achieve proximal embolization. Placement of the plug in a relatively straight vessel segment is important to maximize the apposition between the plug and the vessel wall. However, as exemplified by this case, complete occlusion of the vessel may take a few minutes after the plug is deployed.

CASE 3

A 90-year-old woman presented to the emergency department with acute shortness of breath requiring high-flow oxygen to maintain saturation above 90%. CT angiography of her chest was performed, which showed multiple arteriovenous malformations (AVMs), of which, the largest two were in the right lower lobe. Interventional radiology was subsequently consulted to evaluate the patient for embolization of these symptomatic AVMs.

After gaining access through the right common femoral vein, a 7-F Pinnacle Destination guiding sheath (Terumo Interventional Systems) was advanced into the inferior vena cava. The right pulmonary artery was then selected

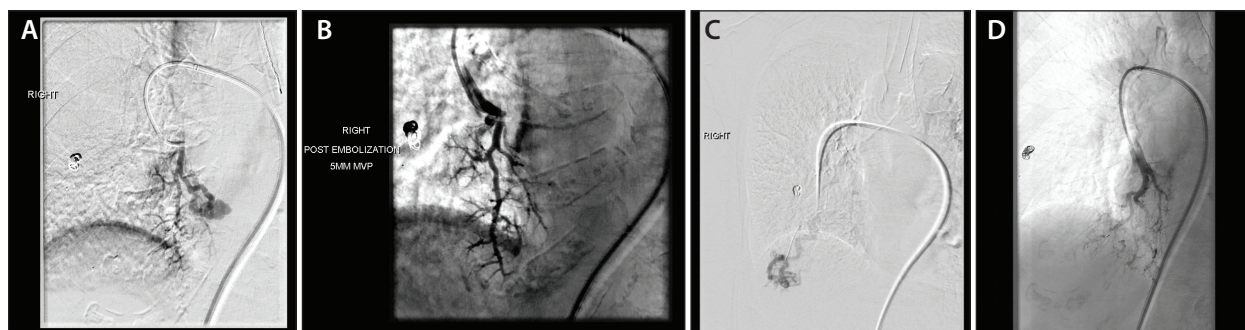


Figure 4. A 90-year-old woman with multiple pulmonary AVMs. A lesion in the right middle lobe (A) was embolized with an MVP™ plug (B). Similarly, a lesion in the right lower lobe (C) was embolized with an MVP™ plug as well (D).

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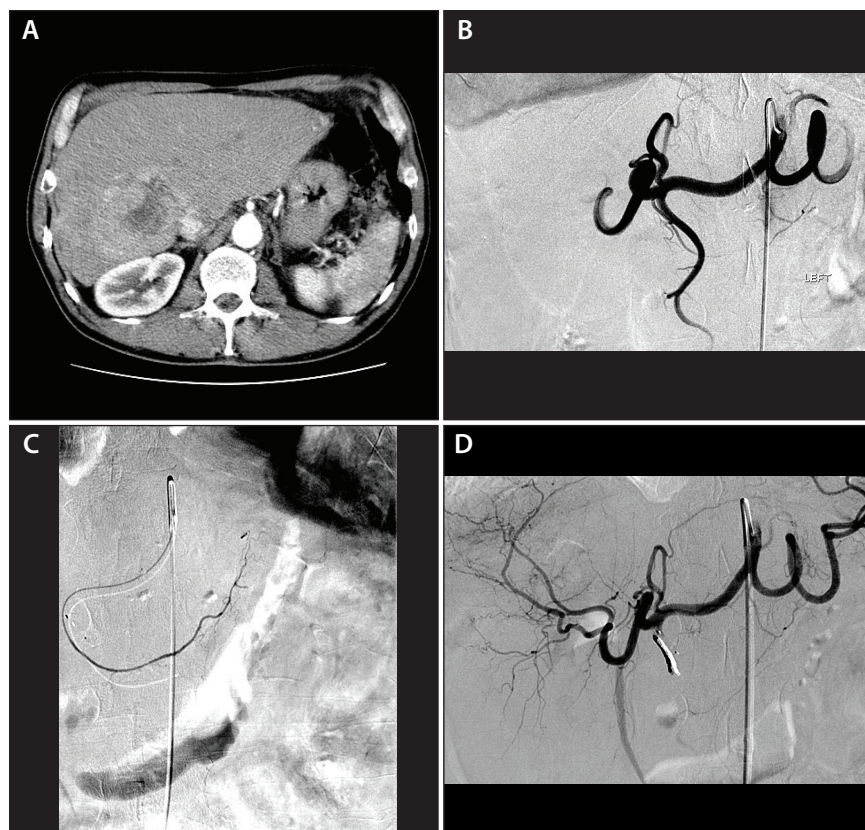


Figure 5. A 64-year-old man was being treated with radioembolization for a metastatic neuroendocrine tumor (A). Mapping angiography showed that the right gastric and gastroduodenal arteries were in close proximity to the anticipated catheter position for radioembolization (B). As a result, the right gastric artery was catheterized (C) and embolized with multiple coils. The GDA was then embolized with an MVP™ plug (D).

using an APC pulmonary catheter (Cook Medical). The sheath was then advanced over the APC catheter to secure right pulmonary artery access. A 5-F Berenstein catheter and 0.035-inch Glidewire were used to select the branch of the right pulmonary artery supplying an AVM. We advanced our sheath into the right pulmonary artery over the pulmonary catheter to secure access. After exchanging the pulmonary catheter for a 5-F Berenstein catheter, a 0.035-inch Glidewire was used to select the main feeding vessel supplying the first AVM (Figure 4A). A Renegade Hi-Flo catheter was then advanced in coaxial fashion toward the nidus of the AVM. Once the microcatheter was secure within the feeding vessel, an MVP-5Q plug was used for embolization (Figure 4B). This process was repeated for the second right-sided AVM (Figure 4C and 4D). In both cases, no additional embolic agents were required for occlusion.

Discussion

When treating patients with pulmonary AVMs, it is desirable to embolize the feeding pulmonary artery

branch as close as possible to the nidus to prevent future recanalization. In addition, the high-flow nature of this pathology necessitates the use of embolic agents that have a low likelihood of passing through the nidus into the venous outflow with a subsequent risk of systemic migration and embolization. The MVP™ plug allows for precise placement within the feeding vessel. The inherent length of the plug, as well as the ability to unsheath the plug and observe its stability within the target artery before repositioning or releasing the plug, helps to address concerns about distal migration. Conrad et al have shown that the MVP™ plug is an effective embolic agent for the treatment of pulmonary AVMs.¹³ In this particular case, we were able to achieve complete embolization of the main feeding arteries supplying both AVMs with just one plug in each vessel, and the patient experienced significant resolution of her dyspnea within 24 hours.

CASE 4

A 64-year-old man with a known neuroendocrine tumor presented for liver-directed therapy. His history was significant for carcinoid syndrome and a progressing hepatic tumor burden (Figure 5A). Because the patient was not a surgical candidate, we offered him radioembolization.

On the day of his mapping arteriogram, the celiac artery was accessed with a VS2 catheter. Mapping arteriography was performed, showing the gastroduodenal artery (GDA) and right gastric artery arising in close proximity to the origin of the left and right hepatic arteries (Figure 5B). In order to prevent ulcer formation via nontarget embolization, a decision was made to proceed with prophylactic embolization of these vessels. A Renegade Hi-Flo catheter was used to catheterize the GDA. An MVP-5Q plug was advanced through the microcatheter and unsheathed in the proximal GDA. It was subsequently deployed once a contrast injection through the microcatheter confirmed that it was appropriately positioned at the origin of the

GDA. The right gastric artery was then catheterized with a Renegade catheter (Figure 5C), and the proximal portion of the vessel was embolized with multiple Concerto detachable coils (Medtronic). Postprocedural imaging showed complete occlusion of both the gastroduodenal and right gastric arteries (Figure 5D).

Discussion

When embolizing the GDA, it is crucial to embolize the vessel as close to its origin as possible to prevent recanalization before radioembolization.¹⁴ In addition, the gastroduodenal artery may arise from the most proximal segment of the GDA, which means that distal deployment of coils or plugs within the GDA may not effectively occlude flow in this vessel. It is therefore important to balance the need to embolize near the origin of the GDA with the risk of migration of the embolic agent into the proper hepatic artery. With the ability to unsheath the plug and confirm the position with a contrast injection before deployment, proximal embolizations within the GDA are possible with a single MVP™ plug, which potentially has both time-saving and cost-saving implications.⁴

CONCLUSION

The MVP™ microvascular plug is an effective device for embolization in a variety of clinical settings. In most cases, this device can lead to immediate vessel occlusion, although time may be required in some patients. Other advantages of this device include its compatibility with existing microcatheters, deliverability through potentially tortuous anatomy, and ability to be resheathed and repositioned before deployment, if needed. As a single device, there are inherent opportunities for both cost savings and time savings, which are both relevant today to the practicing interventionalist. Although these case descriptions represent some examples of its potential utilization, it is clear that the MVP™ microvascular plug can potentially be utilized for a multitude of clinical applications that have traditionally been embolized using multiple coils. ■

The Medtronic MVP™ micro vascular plug system is indicated to obstruct or reduce the rate of blood flow in the peripheral vasculature. Results may vary – Not all patients achieve the same results. Indications, contraindications, warnings, and instructions for use can be found on the product labeling supplied with each device. The Concerto™ detachable coil system is indicated for arterial and venous embolizations in the peripheral vasculature.

CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician.

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