Amplatzer vascular plug IV for occlusion of pulmonary arteriovenous malformations in a patient with cryptogenic stroke

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ABSTRACT

Paradoxical embolism resulting in cryptogenic stroke has received much attention recently, with the primary focus on patent foramen ovale (PFO). However, it is essential to be vigilant in the search for other causes of paradoxical embolic events, such as pulmonary arteriovenous malformations (PAVM). We describe successful closure of pulmonary AVM with a St Jude Medical (Plymouth, MN) Amplatzer™ vascular plug IV. The newer AVP-IV devices can be used for successful embolization of tortuous pulmonary AVM in remote locations where use of other traditional devices may be technically challenging.

Keywords: Amplatzer vascular plug-IV, cryptogenic stroke, paradoxical embolism, pulmonary arteriovenous malformations

INTRODUCTION

Pulmonary arteriovenous malformation (PAVM) is a rare cause of cryptogenic stoke. Surgical resection of PAVM has now been largely replaced by transcatheter device closure. We present the first report of use of the St Jude Amplatzer™ vascular plug (AVP)-IV for occlusion of three PAVMs.

CLINICAL SUMMARY

A previously healthy 25-year-old woman suffered transient ischemic attack (TIA) with sudden onset right leg weakness and dysarthria. A transthoracic echocardiogram (TTE) showed a PFO and device closure was recommended. After a first attempt at closure failed due to inability to cross the inter atrial septum, a second attempt, including a transseptal puncture, resulted in placement of a NMT Medical STARFlex® septal closure device. Both these procedures were performed elsewhere.

Six years later, patient suffered another TIA episode and a repeat TTE with agitated saline contrast was markedly positive for right (R) to left (L) shunt. Patient complained of significant exertional dyspnea and her oxygen saturations were recorded at 96% on room air. Transesophageal echo (TEE) demonstrated an intact septal occluder device and no evidence of intracardiac shunt. Chest computed tomography (CT) angiography showed evidence of R lower lobe (RLL) pulmonary AVMs and anticoagulation therapy with warfarin was initiated. Hypercoagulable workup was negative and no other etiology for stroke was identified.

Cardiac catheterization procedure to occlude the PAVMs was undertaken at our institution. Right pulmonary artery (RPA) angiography demonstrated R to L shunting in the RLL area. Selective balloon occlusion angiography of RLL pulmonary artery disclosed three moderate to large pulmonary AVMs in the medial basal and posterior basal segments. Selective balloon occlusion arterial feeder branch angiograms of all three AVMs were performed. Vessel size measurements and the most distal feeder artery locations for device closure were identified by [Figure 1a-c]. A plan was made to use St Jude AVP-II and/or coils to occlude the PAVMs. Multiple attempts to advance long sheaths and guide catheters to the distal area of the feeder vessels were unsuccessful due to the remote locations and extreme tortuosity of the feeder arterial branches.

A decision was then made to use AVP-IV as they can be delivered via a 4 French catheter. A 6 French balloon wedge catheter was advanced through the right femoral vein (RFV) into the RPA and then exchanged for a 4F Angled

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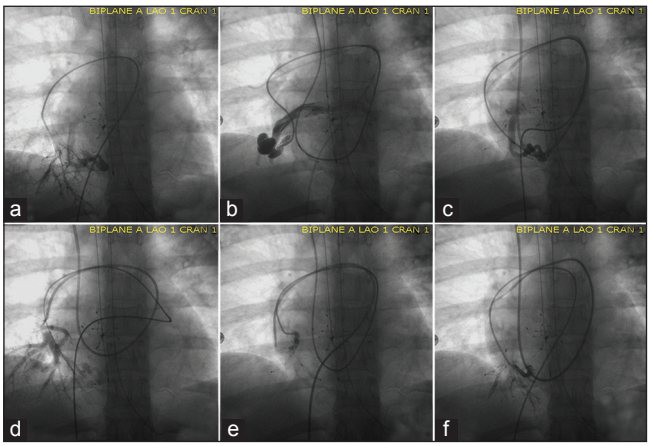

Figure 1: Pre- and post-device closure angiographic still frames of pulmonary arteriovenous malformations in the right lower lobe. Top frame shows preintervention angiography of the feeding arterial and draining venous vessels in the medial basal (a and c) and posterior basal (b) pulmonary artery segments. Bottom frame shows post-AVP-IV device closure of the medial basal branches (d and f) and posterior basal (e) pulmonary artery segment images with no residual shunting

Glide catheter. Next the 4 French angled Glide catheter was advanced into the medial basal PAVM and a 5 mm AVP-IV was deployed. Angiography of the RLL branch with a 6 French balloon wedge catheter, advanced from the right internal jugular vein (RIJV), confirmed good stable position of the AVP-IV, and the plug was released. Also noted on the angiogram was another PAVM in the medial basal branch that was occluded with the above technique with a 7 mm AVP-IV. Similar technique was used to deploy an 8 mm AVP-IV in the posterior basal branch PAVM. Post device release balloon occlusion RLL pulmonary artery angiography documented three well-seated AVP-IV devices with no residual shunting [Figure 1d-f].

Post procedure, the patient was reinitiated back on her home medication regimen that included aspirin and warfarin with recommendations to continue therapy until a follow study has shown complete resolution of her PAVMs. Patient was referred for evaluation of hereditary hemorrhagic telangiectasia (HHT). At her 1-month follow-up visit, patient reported significant improvement in her exertional dyspnea symptoms and her oxygen saturations were 100%. A follow-up bubble echo study, 3 months after the embolization procedure, was positive albeit less strong than her pre-embolization bubble study. A repeat catheterization ensued that showed no evidence of recanalization of the previously occluded pulmonary AVMs. A small additional PAVM was noted in the proximal portion of right middle lobe branch that was successfully occluded with embolization coils.

DISCUSSION

Our case highlights the importance of evaluating for an intrapulmonary shunt as a cause of paradoxical embolism and documents the use of a newer AVP-IV device for successful closure of three PAVMS. About 50-70% of PAVMs are associated with HHT. Since more than one-third of patients with PAVM develop neurologic complications these malformations are commonly treated with embolization, particularly for those with a feeding artery diameter of 3 mm or larger.[1] Treatment of PAVMs with surgical resection or embolization with use of detachable balloons has largely been replaced by transcatheter embolization with use of coils and/or vascular plugs. The primary advantage of coil embolization is ease of deployment and due to their small size can be delivered through a 3-4 French sheath. The disadvantages are inadequate occlusion and distal embolization of coils. Paradoxical embolization of coils/devices, thrombus or air during occlusion of large high flow PAVMs is a dangerous complication that all interventionalists should be aware of. Several techniques have been described to mitigate the risks of paradoxical embolization including bioptome assisted delivery of coils, use of detachable coils/devices, diligent flushing of catheters/long sheaths, and retrograde balloon occlusion of the pulmonary venous channel, accessed after a transseptal puncture of atrial septum.[2]

For the past decade, the St Jude Amplatzer™ vascular plugs have routinely been used for successful embolization of PAVM in both adults and children.[3,4] The four types of AVPs (I-IV) were described in detail in a recent publication by Wang *et al.*[5] Hijazi first reported the use of the original AVP-I for closure of aortopulmonary collaterals.[6] In a series of 120 patients, use of the AVP-I resulted in successful embolization of 120 of 161 (75%) PAVMs without any significant complications.[7] Tabori and Love first reported the use the second generation AVP-II to treat PAVMs.[8] Long-term follow-up of 19 PAVM, 11 treated with AVP-I and 8 treated with AVP-II, demonstrated only one recanalization at 26 months after embolization.[9] Reported advantages of the AVP device over coils are complete occlusion with a single device resulting in shorter procedure time, the ability to occlude shorter length of vessel and potentially faster occlusion time.[7,10] The third generation AVP-III, not available for use in United States, has been used to treat paravalvular leaks.

The newest generation of AVPs, the AVP-IV is a double-lobed occluder device ranging in size from 4 to 8 mm in 1 mm increments and can be delivered through any 0.038" guidewire compatible catheter. This eliminates the need for catheter exchanges and allows delivery and deployment of the device in smaller, remote, and extremely tortuous vessels as demonstrated in our patient. While the AVP-IV has been used for occlusion of arteriovenous fistulas after saphenous vein harvesting, coronary artery fistulas and aortopulmonary collaterals, intercostal arteries from left internal mammary bypass

grafts, and for a variety of peripheral indications,[11-14] to the best of our knowledge, this is the first case of embolization of three PAVMs with AVP-IV devices. Similar to other reports we found that only a single AVP-IV device was adequate to achieve complete and rapid occlusion of the vessel. In this case, the technical difficultly in accessing the PAVM feeder vessel made the use of coils risky, but the flexible delivery cable and smaller profile of the AVP-IV allowed for safe delivery in the most remote and tortuous segments, without the risk of embolism to the left heart.

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