New Technique

Percutaneous Vascular Plug for Incomplete Surgical Left Atrial Appendage Closure

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ABSTRACT: Surgical left atrial appendage (LAA) exclusion has a failure rate as high as 60% due to persistent residual flow in the LAA or large LAA remnants. We describe a novel technique for treatment of incomplete surgical LAA ligation, and define the mechanism that led to persistence of the remnant LAA without any thrombus formation.

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The left atrial appendage (LAA) is well recognized as the primary source of thromboembolism (TE) in atrial fibrillation (AF), accounting for up to 90% of left atrial thrombi in non-valvular AF and 57% in valvular AF, and as such, has been referred to as “our most lethal human attachment.”1,2 This association led to interest in surgical LAA exclusion as early as 1949, with widespread adoption during valvular surgery in the 1990s.3,4 Interest has been further increased with recent innovations in AF surgery and catheter ablation. The available literature on surgical LAA exclusion reveals rates of failure as high as 60% due to persistent residual flow in the LAA or large LAA remnants.5 Furthermore, there is evidence to suggest that incomplete surgical LAA exclusion is more dangerous in terms of thromboembolic complications than no exclusion at all.6 Options for management of incomplete surgical LAA exclusion are limited. We describe a novel approach for percutaneous closure for persistent LAA after failed surgical closure.

Technique Description

A 77-year-old male presented with atypical atrial flutter, mitral regurgitation, coronary artery disease with prior saphenous vein graft (SVG) to left anterior descending (LAD) bypass grafting in 1984, percutaneous coronary intervention of the LAD through SVG in June of 2013, diabetes, and hyperlipidemia. CHADS$_2$ score was 2, CHADS-VASC score was 4, and HAS-BLED score was 1. He underwent reoperation on February 13, 2013 with a surgical Cox MAZE III procedure and mitral valve repair with placement of an Edwards 28 mm Physio annuloplasty ring. The LAA was ligated in three layers using linear running sutures of 3-0 polypropylene.

Postoperatively, he was placed on full anticoagulation with warfarin, according to the local protocol following mitral repair with MAZE. A transesophageal echocardiogram (TEE)
performed 5 months later prior to an electrical cardioversion demonstrated flow into the LAA on color Doppler (Figure 1). There was no thrombus seen in the appendage. He was referred for percutaneous closure.

Using general anesthesia with TEE guidance, a transseptal puncture was performed and a 5 Fr MP-2 catheter was used to direct a 0.035˝ hydrophilic guidewire into the partially closed LAA. The hydrophilic wire was chosen based on our experience with paravalvular leak closure, and other wire options might be used with less risk of perforation of the LAA pouch. The catheter position was confirmed by angiography (Figure 2). An 8 mm Amplatzer Vascular Plug-4 (AVP4; St Jude Medical) was placed in the leak (Figure 3) via the 5 Fr MP-2 catheter, with complete cessation of flow into the appendage confirmed both angiographically and by color-flow Doppler (Figure 4). TEE exam 4 months later showed the plug in stable position, no flow through the leak, and no thrombus on the left atrial side of the device.

Discussion

The reported risk of thrombus formation in a partially closed LAA is over 40%.5-7 This high rate of incomplete closure may reflect ascertainment bias introduced by more careful scrutiny of patients who have problems after surgery. In any case, incomplete closure after surgical closure does occur. Follow-up TEE might be considered more frequently after surgical LAA closure in light of the option to treat this problem percutaneously. In this case, the entry into the remnant LAA is small. It is not apparent why this LAA would remain open, rather than slowly filling with thrombus and then finally closing. Hemodynamic evaluation in this patient during sinus rhythm sheds light upon the mechanism by which this large remnant with a small orifice would remain un-thrombosed. Color Doppler images show flow into and out of the LAA through the point of incomplete closure at different phases of the cardiac cycle (Figure 5). Hemodynamic recordings from the LA cavity and LAA also show a large pressure gradient favoring flow into the LAA at end-systole, with the 40 mm Hg LA V-wave, and out of the LAA at end-diastole or very early systole associated with a 90 mm Hg peak pressure recorded from within the LAA itself (Figure 6). This relatively large pressure gradient and a predominance of sinus rhythm after MAZE appears to favor flow rather than stasis and limit the potential for complete thrombotic occlusion of this incompletely ligated LAA remnant. A similar mechanism has been reported in a giant saphenous bypass graft stump aneurysm with a narrow neck.8

Device use to treat incomplete surgical LAA closure has not been well described. Matsumoto et al recently reported...
use of a Helex Septal Occluder for this indication in a single case. The size of the entry into the remnant LAA was reported as 7 mm, which required a larger-diameter occluder. A 10 Fr delivery device was placed transseptally for delivery of the 15 mm diameter occluder. In the current case, the defect was smaller and crossed with a 5 Fr diagnostic catheter, which is capable of delivering up to an 8-mm diameter AVP4 vascular plug. Together, these cases demonstrate that it is feasible to occlude the LAA after incomplete surgical closure. Numerous devices, such as closure devices for atrial septal defects and vascular plugs, can be suitable for this goal. The choice depends on the anatomical characteristics of the residual shunt and the LAA itself. It is anticipated that complete LAA occlusion in such cases will lead to a lower clinical thromboembolic risk. The availability of novel transcatheter approaches for incomplete surgical LAA closure represents a significant step for management of these patients.

References