

Percutaneous Repair of Aortic Puncture With Amplatzer Closure Device During Attempted Transseptal Puncture

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ABSTRACT: Attempted atrial transseptal puncture in a 63-year-old man undergoing an ablative procedure for atrial fibrillation was complicated by inadvertent delivery of an 8 Fr sheath across the aorta. Due to obesity-related perioperative risks, we opted for percutaneous repair rather than open-heart corrective surgery. Our case is unique for the novel percutaneous delivery of an Amplatzer atrial septal defect (ASD) closure device to the defect in the non-coronary aortic cusp through an 8 Fr left atrial multipurpose sheath not designed for this purpose. At 9-month follow-up, he had a mild residual internuclear ophthalmoplegia.

J INVASIVE CARDIOL 2013;25(5):E110-E113

Key words: atrial transseptal puncture, complications

Inadvertent aortic puncture is a recognized complication of attempted atrial transseptal puncture. Subsequent delivery of a sheath across the aortic wall is a potentially life-threatening complication that mandates immediate repair. Typically, this repair is an open-heart procedure via midline sternotomy. We present the case of a 63-year-old man who underwent percutaneous repair of an iatrogenic aortic injury sustained during attempted transseptal puncture. Our case is unique for the novel percutaneous delivery of an Amplatzer atrial septal defect (ASD) closure device to the defect in the non-coronary cusp of the aorta.

Case Report. The patient was to undertake pulmonary vein isolation for paroxysmal atrial fibrillation (AF) under general anesthesia. His comorbidity included obesity (130 kg), hypertension, and obstructive sleep apnea. Left ventricular and right atrial parameters were normal, and the left atrium (LA) was mildly dilated (area, 25.1 cm²). He was anticoagulated on warfarin and his international normalized ratio (INR) on the day of the procedure was 2.6.

The transseptal attempt was made under fluoroscopy with a Brockenbrough (BRK 1) needle via an 8 Fr (outer diameter, 3.6 mm [10.6 Fr]; inner diameter, 2.6 mm), 63 cm left atrial multipurpose (LAMP) 45° curve sheath in the right femoral vein. Mis-

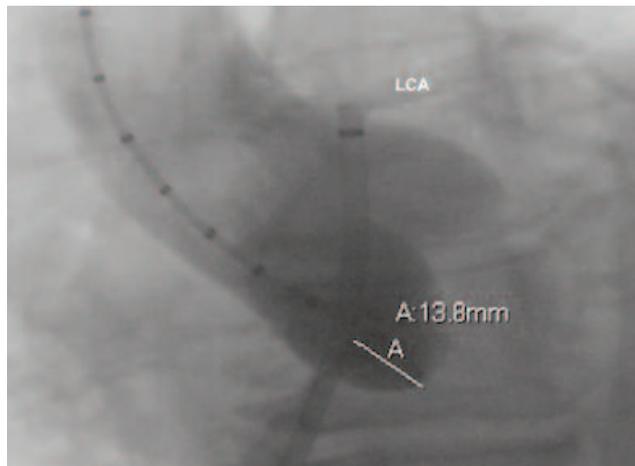


Figure 1. Anteroposterior fluoroscopic projection of contrast-enhanced proximal aorta. The sheath enters the non-coronary cusp 13.8 mm distal to the aortic valve. LCA = left coronary artery.

led by equivocal pressure, fluoroscopic, and contrast checks, the LAMP sheath was inadvertently delivered to the proximal aorta via the non-coronary cusp (NCC), with the tip coming to rest in the left coronary cusp.

On realization of the error, the sheath was left in the proximal aorta under constant irrigation with heparinized saline. The warfarin was reversed with 10 mg of intravenous vitamin K and 4 U of fresh frozen plasma. The patient remained hemodynamically stable throughout. Echocardiography revealed no pericardial collection and the absence of significant aortic regurgitation (AR).

The options for repair were an open-heart procedure via midline sternotomy or percutaneous closure with an Amplatzer self-centering ASD closure device. Due to the patient's morbid obesity, we opted for a percutaneous approach undertaken in the coronary angioplasty suite.

A left anterior oblique to right anterior oblique spin acquisition in the catheter laboratory confirmed sheath entry into the non-coronary cusp, 13.8 mm from the aortic valve (Figure 1). A transesophageal echocardiogram was performed to confirm that the sheath had not traversed a potential pericardial space or passed from the right atrium (RA) to the left ventricle via the membranous septum, crossing the aortic valve retrogradely (Figure 2). Recognizing the importance of leaving the LAMP sheath in place, we devised a method of delivering the closure device through the LAMP sheath. Since the 8 Fr LAMP sheath's external diameter was 3.6 mm, we used a 4 mm Am-

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Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Stiles is on the Advisory Board and has received travel expenses from Boston Scientific and reports travel expenses and lecture honoraria from Medtronic, Biosense Webster, and St. Jude Medical. Dr Pasupati is a paid consultant and member of the Advisory Board and Speaker's Bureau for Medtronic, and is an unpaid consultant for St. Jude Medical and Edwards LifeSciences.

Manuscript submitted November 14, 2012, provisional acceptance given November 22, final version accepted December 11, 2012.

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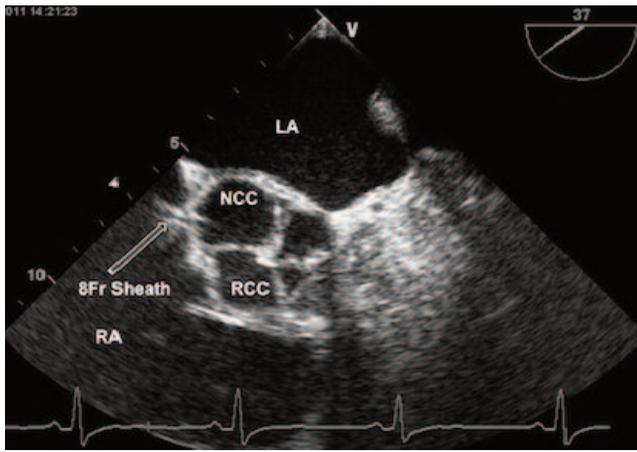


Figure 2. Transesophageal echocardiogram, transverse section through the aortic cusps. The arrow identifies the 8 Fr left atrial multipurpose sheath entering the non-coronary cusp (NCC) of the aorta from the right atrium (RA). LA = left atrium; RCC = right coronary cusp (of aorta).

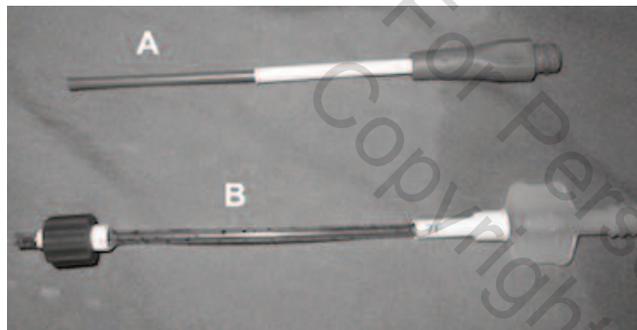


Figure 3. (A) The shortened 8 Fr multipurpose guiding catheter. (B) The 7 Fr Amplatzer TorqueVue delivery system.



Figure 4. The multipurpose guiding catheter and Amplatzer TorqueVue delivery system connected together.

platzer ASD closure device. The radius of the aortic disc is 8 mm, and had a clear margin from surrounding structures, especially the aortic valve. The 2.6 mm internal diameter of the 8 Fr LAMP sheath was sufficient to accommodate the crimped 4 mm ASD device, but could not be directly attached to the smallest available Amplatzer TorqueVue delivery system (7 Fr; outer-diameter 2.7 mm). Instead, the delivery system was connected to an 8 Fr multipurpose guiding catheter that was cut short to accommodate the delivery cable (Figures 3 and 4). The Amplatzer device was loaded in the usual fashion and connected

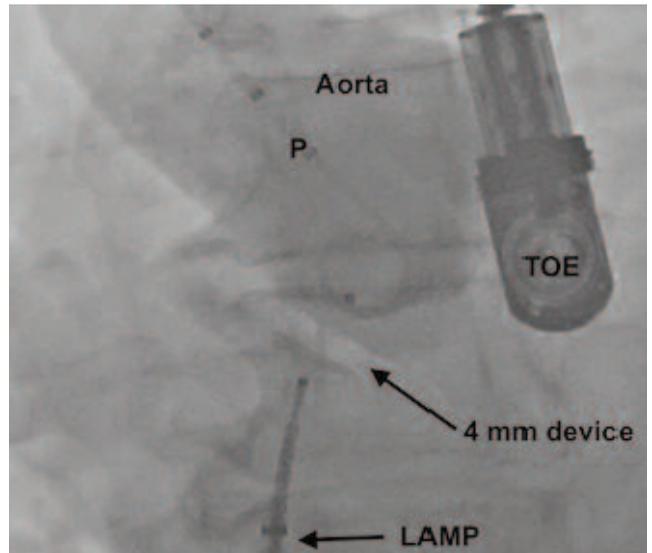


Figure 5. Anteroposterior fluoroscopic projection of contrast-enhanced proximal aorta. This image captures the moment immediately prior to release of the deployed closure device. LAMP = left atrial multi-purpose sheath; P = pigtail catheter in aorta; RA = right atrium; TOE = transesophageal probe.

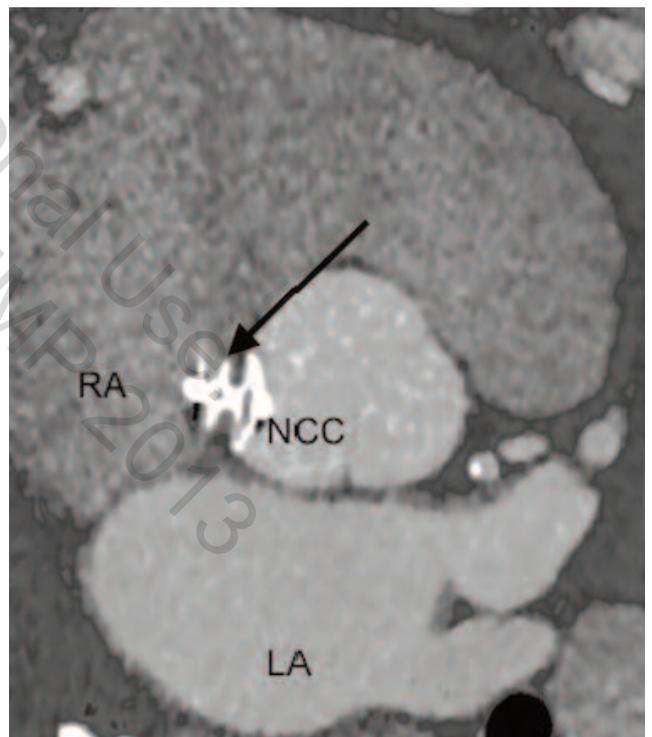


Figure 6. Contrast computed tomography. Angled transverse section demonstrating the Amplatzer closure device (identified by arrow) deployed between the right atrium (RA) and the non-coronary cusp (NCC) of the aorta, and its anterior relationship to the left atrium (LA).

to the multipurpose catheter that was inserted a short distance within the LAMP sheath. The device transitioned smoothly from the delivery system to the shortened guide catheter and LAMP sheaths, and deployed across the defect. Direct contrast injection within the RA and

aortic cusp suggested no persisting aorto-atrial communication (Figure 5) and echocardiography excluded any aortic leaflet compromise. A postprocedure CT scan confirmed a well-seated device between the NCC of the aorta and the right atrium that was clear of the aortic leaflet (Figures 6 and 7).

Clinical and radiologic assessment on the first postoperative morning identified a small brain-stem stroke (internuclear ophthalmoplegia). Its precise mechanism and timing was not clear. At 9-month follow-up exam, the patient had very slight residual diplopia when looking down and to the left.

Discussion. Major complications of AF ablation including inadvertent aortic puncture, pericardial tamponade, and stroke occur in up to 4.5% of cases.¹ Some of these relate to the transeptal puncture.

Iatrogenic fistulae ordinarily require open repair via sternotomy, yet there are reports of percutaneous repair of LA-to-aorta fistulae,^{2,3} periprosthetic valvular leaks,⁴ and left aortic sinus-to-RA fistulae⁵ with closure devices. We describe the percutaneous repair of an RA-to-aorta communication sustained during attempted transeptal puncture. There is one other report of a similar technique for the same injury⁶ in which the authors describe exchanging 8 Fr sheaths in the aorta. Sheath exchange on a wire has the potential for hemodynamically significant blood loss. At times we may not be able to re-cross on the wire with the delivery system or worsen the size of the fistula due to direct trauma. We describe a different, important technique whereby the sheath is left in place and the catheter system is modified to allow the safe delivery of the closure device. Our key observations are discussed below.

First, it is important not to panic when aortic puncture is realized. If only the needle punctures the aorta, it may be removed without complication, but if the sheath is delivered, its immediate removal may result in catastrophic pericardial tamponade or extravasation. However, maintenance of access and attempted percutaneous repair through a non-uniform sheath presents a number of technical considerations.

The Amplatzer delivery system does not connect to a LAMP sheath. This was overcome using a shortened multipurpose guiding catheter as a conduit between the LAMP sheath and the Amplatzer loading system.

The standard (110 cm) Amplatzer wire was too short if the full length of the coronary guide catheter was to be used. This may be overcome by connecting two Amplatzer delivery cables to the male and female ends or by shortening of the sheath/catheter apparatus, as we did with this case.

It was necessary to ensure that deployment of the closure device did not impinge on aortic leaflet function including repeated trauma to a leaflet by the central device pin during ventricular systole. The non-protruding pin of an Occlutech ASD closure device may be advantageous in this scenario and a self-centering mechanism minimizes the risk of device movement once delivered. Given the elasticity of the aortic wall, there is no need to oversize the device.

The dimensions of the device disks were carefully considered

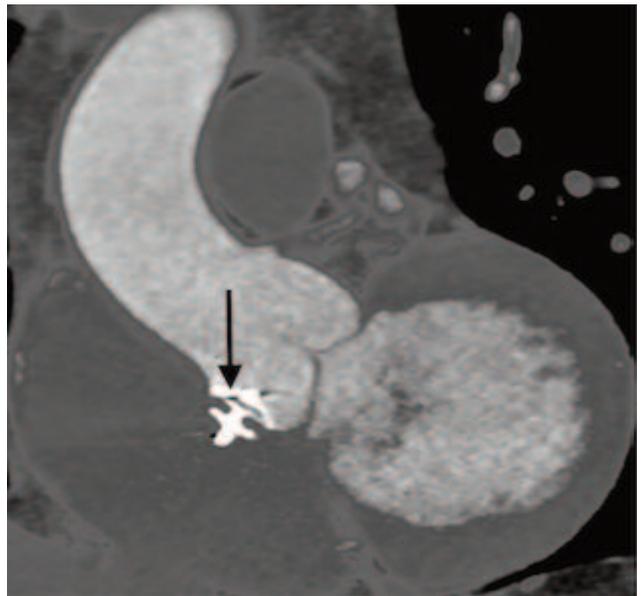


Figure 7. Contrast computed tomography. Angled sagittal plain illustrating the Amplatzer closure device (identified by arrow).

in relation to the proximity of the aortic defect to the valve leaflets, and the degree of AR was assessed pre- and postprocedure. Late cardiac erosion following ASD closure with a septal occluder device is recognized,⁷ but the incidence of late erosion in this scenario is unknown.

The periprocedural anticoagulation strategy must consider the thrombogenicity of a sheath in the left circulation against the risk of uncontrolled bleeding into the pericardial space. We opted to reverse anticoagulation immediately when aortic puncture was realized. However, if there is no active bleeding, it may be favorable not to reverse the anticoagulation to reduce the risk of systemic embolization. After device deployment, dual-antiplatelet therapy will continue for 3 months followed by ongoing single-agent warfarin.

Preferably, aortic or pericardial puncture is avoided altogether and we perform a number of checks during the transeptal puncture to reduce the risk of complication. With the BRK needle sitting just back from the LAMP sheath dilator tip, we draw down from the superior vena cava, observing the "step" onto the fossa ovalis FO under anteroposterior (AP) fluoroscopy. The superior-inferior and anterior-posterior orientations are checked in left and right anterior oblique projections, respectively, and the puncture is made under continuous AP fluoroscopy and needle-tip pressure monitoring. We then aspirate oxygenated blood, and inject contrast. Finally, we advance a wire and ensure its positioning beyond the cardiac silhouette before advancing the dilator and sheath over the wire. Despite these checks, we were misled into thinking entry had been made to the LA.

Some centers utilize intracardiac echocardiography (ICE) to directly visualize the transeptal apparatus onto the FO. It is the authors' opinion that the significant costs of an ICE-guided

transseptal puncture strategy are not justified to achieve a small reduction in complications.

Conclusion. Percutaneous repair of RA-to-aorta fistulae with an Amplatzer closure device is achievable and may be preferred over open-heart repair. We describe a novel technique that may provide guidance to operators in a similar predicament.

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