Direct Percutaneous Repair of Left Ventricular Pseudoaneurysm

via Transthoracic Deployment of a Ventricular Septal Defect Closure Device

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In this case report, we describe direct percutaneous delivery of a muscular-ventricular-septal-defect occluder device to close a left ventricular pseudoaneurysm. The occluder was positioned and deployed with the aid of concurrent transthoracic ultrasonography, transesophageal echocardiography, and fluoroscopy. In contrast with previously published reports, we describe and illustrate a direct transthoracic route across the pseudoaneurysmal sac, which obviated the need for indirect transfemoral or transapical approaches. (Tex Heart Inst J 2015;42(4):362-6)

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Left ventricular (LV) pseudoaneurysms—ruptures of the endocardium and myocardium contained only by adherent pericardium—are rare sequelae of infarctions, cardiac surgery, infections, or chest trauma. The prognosis is exceptionally poor: mortality rates of up to 45% if treated medically,¹ and 7% to 20% if treated surgically.^{1,2} More recently, multiple authors have described endovascular repair with use of a ventricular septal defect (VSD) AMPLATZER® occluder device (St. Jude Medical, Inc.; St. Paul, Minn) deployed via a transarterial route³ or a transvenous route.⁴ Dudy and colleagues⁵ have described a transapical approach through the pseudoaneurysmal sac, in 2 patients; however, no images of this approach were provided. We report our initial experience with this technique.

Case Report

In January 2012, a 72-year-old woman initially underwent cardiopulmonary bypass for open graft repair of an ascending aortic dissection, at another hospital. The procedure was complicated by ventricular fibrillation arrest and anterior myocardial infarction. Over the course of the next year, she underwent multiple endovascular procedures for the management of sequelae of a continuous descending and abdominal aortic dissection.

In April 2013, the patient underwent open surgical repair (with insertion of a descending aortic graft) of persistent type II endoleaks that had occurred proximally and distally in the thoracic aorta. She then experienced knee numbness, which was attributed to spinal ischemia. At the time, no further sequelae of the aortic procedure—or of cardiopulmonary bypass, including LV cannulation—were noted. However, one month after the surgical procedure the patient developed persistent band-like pain across the lower chest. This prompted contrast-enhanced computed tomographic angiography (CTA), which revealed a large pseudoaneurysm arising from the anterior wall of the LV and surrounding, but discrete from, the left anterior descending coronary artery (LAD) (Fig. 1). The patient then presented at the Interventional Radiology Section for consultation.

Given the patient's pain (as illuminated by our subsequent CTA discovery of the large LV pseudoaneurysm), we decided to proceed with closure. Because of scant published experience with the treatment of such a condition, we consulted local specialists in congenital cardiology, cardiothoracic surgery, and interventional cardiology, in order to select the optimal equipment and approach. Rejected options included 1) surgical closure (because of the patient's refusal—together with the high morbidity and mortality rates associated with repeat sternotomy and repair); 2) transfemoral clo-

sure with an AMPLATZER occluder device (for fear both of LAD compression by the occluder's epicardial plate, and of the occluder's distal migration); and 3) direct percutaneous puncture and coil embolization (because of the high risk of non-target myocardial tract embolization). After careful consideration of the pseudoaneurysm's geometry and the patient's comorbidities, we decided to proceed with AMPLATZER VSD closure after direct percutaneous puncture of the pseudoaneurysmal sac.

Fig. 1 **A)** Contrast-enhanced axial computed tomographic angiogram of the chest shows a narrow 2-mm neck (arrowhead) communicating anteriorly between the left ventricle and the pseudoaneurysm (arrow). Note also the thrombosed descending thoracic aortic pseudoaneurysmal sac and dissection, after repair. **B)** Computed tomographic angiogram (volume-rendered 3-dimensional reconstruction in left anterior oblique view) shows the relationship of the pseudoaneurysm (arrow) to the left anterior descending coronary artery (arrowhead). The site of the repaired ascending aortic dissection is also seen (asterisk).

Extensive preprocedural 3-dimensional (3D) mapping was performed with CTA volumetric data, which enabled precise planning of the percutaneous puncture trajectory (Fig. 1B). Because the pseudoaneurysm straddled the LAD, that coronary artery was selected, studied, and subsequently demarcated with an 0.018-in wire. The patient was maintained on intravenous heparin to achieve an activated clotting time of 200 s. Transesophageal echocardiography was performed concurrently with transthoracic ultrasonographic and fluoroscopic guidance, as the lateral lobe of the pseudoaneurysmal sac was punctured and the myocardial defect cannulated. Under direct ultrasonographic guidance, the beating LV pseudoaneurysm was entered with a 22G Chiba needle (Fig. 2). An 0.018-in wire was then inserted through the myocardial defect, into the LV outflow tract (Fig. 3). The access tract was enlarged by means of a Neff Percutaneous Access Set (Cook Medical, Inc.; Bloomington, Ind) and a 6F vascular sheath, through which a muscular-VSD occluder device (6-mm waist $\times$ 14-mm diameter) was subsequently deployed with the aid of constant fluoroscopic and transesophageal echocardiographic guidance (Figs. 4 and 5). The endocardial plate was flared outward, and the epicardial plate was maintained in the tract. Stability within the myocardial tract was confirmed with push-pull testing, and the device was deployed. After deployment, ventriculography and echocardiography confirmed the absence of a persistent leak into the pseudoaneurysm

Fig. 2 Transverse ultrasonographic image shows percutaneous needle access of the right lateral lobe of the pseudoaneurysm (echogenic point delineated by arrow). An echogenic wire resides within the left anterior descending coronary artery (arrowhead), and the left lateral lobe (asterisk) of the pseudoaneurysm lies opposite.

(Fig. 6), and the sheath was removed under ultrasonographic guidance without incident. Although thrombin

Fig. 3 Fluoroscopic image obtained during percutaneous access shows the needle positioned in the pseudoaneurysm (black arrowhead), with the 0.018-in wire cannulating the myocardial defect, looping in the left ventricle, and exiting the left ventricular outflow tract (arrow). Another 0.018-in wire demarcates the left anterior descending coronary artery (white arrowhead).

Fig. 4 Fluoroscopic image obtained after deploying the occluder device's endocardial footplate (arrow) along the anterior wall of the left ventricle. The epicardial footplate (black arrowhead) remains elongated along the pseudoaneurysmal neck, a placement that was performed intentionally to avoid compression of the left anterior descending coronary artery (LAD) and to enable greater stability and occlusion throughout the cardiac cycle. An 0.018-in wire (white arrowhead) remains within the LAD.

had been prepared, the initial ultrasonographic images ruled out the need for additional embolization by revealing immediate thrombosis of the pseudoaneurysmal sac. The patient was maintained on aspirin (81 mg daily) after the procedure. Subsequent CTA confirmed continued closure at 3 months, together with patency of the adjacent LAD (Fig. 7). In August 2014, CTA showed persistent closure at 16 months.

Discussion

Although we know that LV pseudoaneurysm is rare, we do not know its true incidence; treatment options are described in scattered case reports and in small case series. Complications include tamponade from complete rupture, embolization causing stroke and other sequelae, and severe mitral regurgitation. On the basis of case reports and series from 1966 through 1997, Frances and colleagues¹ described mortality rates as high as 45% in medically managed patients. However, more recent case series have reported better survival rates in conservatively managed patients, with no deaths from rup-

Fig. 5 Color-flow Doppler image from transesophageal echocardiography performed during device deployment shows the echogenic occluder device (LV disc) positioned through the sheath in the left ventricular lumen; this occluder was subsequently retracted against the left ventricular wall. The interventricular septum (IVS) and pseudoaneurysm (PSA) are also seen.

Fig. 6 Ventriculogram, obtained after deployment by means of a pigtail catheter positioned in the left ventricle (asterisk), shows the occluder device (arrow) in place and no residual filling of the pseudoaneurysmal sac.

Fig. 7 Computed tomographic angiogram (sagittal maximal intensity view) 3 months postprocedurally shows the occluder device (black arrow) in stable position along the anterior wall of the left ventricle (asterisk). The left anterior descending coronary artery is seen anteriorly and remains widely patent (white arrow) in the presence of persistent pseudoaneurysmal occlusion.

ture in a series of 9 patients who were monitored over a period of 48 months.⁶ Increasingly, surgery is being avoided in asymptomatic patients with comorbidities and incidental pseudoaneurysms, because the surgical mortality rate in these patients might outweigh that of conservative therapy.^{6,7} Hence, endovascular repair techniques are an increasingly chosen option in patients

with multiple comorbidities or other factors that preclude surgery.

Transarterial and, less often, transvenous endovascular techniques have been successful in repairing LV pseudoaneurysms multiple times.^{3,4,8,9} Transapical repair of an ascending aortic pseudoaneurysm has been reported,¹⁰ and direct percutaneous puncture of the pseudoaneurysmal sac has been described in 2 patients,⁵ although images were not provided and the causes and anatomic locations of these pseudoaneurysms were at variance with our case. In our patient, anatomic considerations favored a direct percutaneous approach through the pseudoaneurysmal sac; the 2- to 3-mm defect along the anterior free wall would have been an extremely challenging target via a transfemoral approach, particularly in a beating heart. In addition, the patient's thin habitus provided an excellent transthoracic acoustic window during real-time puncture of the pseudoaneurysm. Preprocedural 3D reformatting of cross-sectional imaging studies was crucial in identifying the appropriate obliquity for the imaging intensifier, as well as the puncture angle, which enabled rapid cannulation of the pseudoaneurysm defect. Specific anatomic criteria for use of the muscular-VSD closure device also include a narrow neck; we recommend oversizing the device by at least 5 or 6 mm, given the anticipated transient neck enlargement and mobility along the anterior wall of the LV. This limitation confines the technique to pseudoaneurysmal necks of (at most) 10 to 12 mm, given the maximal device waist of 18 mm. In addition, only defects along the anterior wall or apex are amenable to a direct percutaneous approach.

Conclusion

Our case report describes the successful use of a muscular-VSD occluder device that we deployed via a percutaneous approach, using concurrent echocardiography, fluoroscopy, and ultrasonography. This technique resulted in durable occlusion of an LV pseudoaneurysmal neck and in thrombosis of the sac. Although this technique might be limited in its application because of the pseudoaneurysm's predilection for the LV posterior wall, in cases affecting the anterior wall or (potentially) the apex, it adds to a growing armamentarium of minimally invasive treatment approaches in this challenging patient population.

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