Hybrid Endovascular Pseudoaneurysm and Pulmonary Stenosis Repair in Bovine Arch
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This case report details the endovascular management of a large aortic pseudoaneurysm in a high-risk patient with a complicated history using a multi-disciplinary, hybrid approach. The pseudoaneurysm compressed the main pulmonary artery to 5 mm with near complete obstruction of the left main pulmonary artery, while also compromising the lumens of the left superior pulmonary vein and left main bronchus. Furthermore, the patient’s left upper extremity arteriovenous dialysis fistula and vein and left main bronchus. Furthermore, the patient’s left upper extremity arteriovenous dialysis fistula and bovine arch anatomy required a hybrid approach of repair that preserved the fistula while treating the aortic, pulmonary, and bronchial pathology.

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A 57-year-old man presented with increasing shortness of breath. He had a history remarkable for type II diabetes mellitus, hypercholesterolemia, coronary artery disease, and colon cancer. In addition, he was on dialysis through a left upper arm fistula for end-stage renal disease.

The patient’s surgical history included a quintuple aortocoronary bypass graft 5 years earlier, with the left internal mammary artery grafted to the left anterior descending coronary artery and reverse saphenous vein grafts to the superior marginal, second obtuse marginal, diagonal, and posterior descending coronary arteries. Three years prior, a 3.0 × 12-mm stent was placed in the proximal left anterior descending coronary artery and catheterization showed disease progression with failure of his left internal mammary artery graft. Cardiac catheterization performed 2 years later showed 100% occlusion of the left circumflex, mid-right coronary, and left internal mammary arteries. An echocardiogram also showed moderate left ventricular systolic dysfunction (ejection fraction, 41%) with 1+ mitral insufficiency.

A contrast computed tomographic (CT) scan performed at presentation revealed a large contained left anterior and lateral mediastinal pseudoaneurysm (PSA) distal to the takeoff of the left subclavian artery (Fig 1). Given the patient’s antecedent cardiac catheterization and prior stent graphing with his PSA appearing soon after, the PSA was believed to be iatrogenic. The PSA extended laterally to the left aortic arch causing severe compression of the main pulmonary artery (PA). There was near complete obstruction of the left PA and left superior pulmonary vein, with impingement of the left main stem bronchus (Fig 2). The findings were also notable for bovine aortic arch anatomy with the left common carotid artery and right innominate artery arising from a common trunk.

Given his significant comorbidities, the patient refused an open conventional repair; therefore, an endovascular approach was offered as an alternative. He initially underwent a left carotid-subclavian bypass to preserve his dialysis fistula through a typical supraclavicular approach using a 6-mm graft. Once completed, a 100-cm marker pigtail catheter was placed into the aorta. Thoracic arch aortography was performed along with an intravascular ultrasound of the iliac arteries, aorta, innominate, and subclavian vessels to locate the source of the PSA. The aortic arch was measured to be approximately 23 mm, and the iliac arteries measured to be approximately 10 mm in diameter, allowing for transfemoral stent-graft placement. An intravascular ultrasound demonstrated the aortic communication with the PSA just distal to the left subclavian artery.

A 28 mm in diameter and 11.5 cm in length Medtronic Talent stent-graft (Medtronic, Minneapolis, MN) was selected for the PSA repair and delivered over a Lunderquist wire (Cook Medical Inc, Bloomington, IN) into the arch and descending thoracic aorta. Both fluoroscopy and angiography were used to deploy the uncovered portion of the graft across the bovine innominate artery and the covered portion across the left subclavian artery origin. Completion angiography showed the device to be patent and with a good seal. A CT scan on postoperative day 2 demonstrated a stable PSA. From concern of the continued type I endoleak from the subclavian artery, an endovascular occlusion of the left subclavian artery using an Amplatzer II plug (AGA, Minneapolis, MN) was performed. A repeat CT was performed on postoperative day 4, which showed no acute changes.

One month later, the patient was readmitted with symptoms of orthostasis, increased lower extremity edema, left-sided chest pain, and dyspnea on exertion. An echocardiogram showed severely dilated right-sided chambers, a reduced right ventricle systolic function, and a PA outflow obstruction secondary to compression (maximum gradient, 28 mm Hg; peak velocity, 264 cm/s; systolic pressure, 65 mm Hg). A thoracic CT showed a persistent type IA endoleak with filling of the PSA and severe compression of the left PA. The endoleak was treated with a Simmons catheter (Merit Medical Systems Inc, South Jordan, UT) placed through the proximal portion of the graft into the PSA sac with placement of multiple metallic coils. A Palmaz stent (Cordis, Bridgewater, NJ) was subsequently dilated to 30 mm to overexpand the proximal portion of the graft and seal the endoleak. Because the endoleak required subsequent coil embolization and Palmaz stent (Cordis) placement across the proximal portion of the original stent-graft, the endoleak was determined to be a type IA and not a type II. Angiography showed successful occlusion of the endoleak with no flow in the PSA and some residual flow in the left subclavian.

A pulmonary angiogram showed a pressure of 44/7 with a patent right PA and extrinsic compression of the left PA by the PSA sac. A 20 × 45-mm Wallstent (Boston Scientific, Natick, MA) was deployed and dilated to 20 mm (Fig 3). A 3-month follow-up CT later showed the

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PSA to be shrinking, the stent-graft to be in good position, and the PA continued to remain patent (Fig 4), with resolution of his clinical symptoms.

Comment

Pulmonary artery stenosis has been described in patients with aortic arch pseudoaneurysms [1, 2]. In this case, the pulmonary compression from the PSA was unique in its sheer severity, as the central main PA was compressed to 5 mm. In addition, there was near complete obstruction of the left main PA (to 1 mm) and the left superior pulmonary vein with severe attenuation of the left mainstem bronchus. After endovascular repair, the phlegmon from this PSA continued to compress the left PA. The patient had some symptoms, but these increased to the point that treatment was required due to the slower than anticipated resolution of the PSA. The right ventricular dysfunction from his pulmonary hypertension, in addition to the endoleak, ultimately necessitated both embolization and PA stent deployment to definitively treat the PSA.

Due to the location of the PSA, just distal to the origin of the left subclavian artery, only residual blood would supply the arteriovenous fistula. Therefore, a left carotid-subclavian bypass preceded the PSA repair to maintain adequate flow. In addition, performing the bypass required acknowledgement of the patient’s “bovine aortic arch,” with the common origin of the innominate and left common carotid arteries. A variation seen in as much as 13% of patients [3]. In this case, special consideration must be made regarding the route of arterial return and technique of anastomosis [4]. Thus, the endovascular stent-graft was delivered across both the innominate and

![Fig 1. Preoperative computed tomographic scan of the pseudoaneurysm (PSA) (thick arrow) arising from aortic arch (thin arrow). The dimensions were 12.4 cm × 8.1 cm. The flow is seen within the PSA.](image1)

![Fig 2. Preoperative computed tomographic scan of pseudoaneurysm (thick white arrow) causing compression of the pulmonary artery (PA) trunk, with near total compression of the left main PA (thin white arrow) and the left mainstem bronchus (black arrow).](image2)

![Fig 3. Computed tomographic scan demonstrating successful placement of pulmonary artery (PA) stent (thin white arrow) with re-expansion of the main PA, left PA, and the left mainstem bronchus (black arrow). The resolving PSA is shown (thick white arrow).](image3)

![Fig 4. Computed tomographic image of the pseudoaneurysm (PSA) (thick arrow) shrinking in size with the stent-graft in place. The dimensions were 6.7 cm × 6.1 cm. The flow was no longer seen within the PSA.](image4)
subclavian arteries to eliminate communicating blood flow to the PSA and achieve an adequate seal. This case further highlights the importance of an individualized hybridized approach in patients with end-stage renal disease, heart disease, or severe comorbidities. The continued development of endovascular and hybrid approaches offers surgical alternatives to that of conventional open surgery for complex aortic and pulmonary vascular disease.

References