Percutaneous thoracic endovascular aortic repair for ascending aortic pseudoaneurysm after prosthetic aortic valve repair

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Ascending aortic pseudoaneurysms are an uncommon and challenging surgical problem that requires intervention to avoid rupture and hemorrhage. Preceding cardiac procedures often compound the high rate of morbidity and mortality associated with open repair. A case is described of an iatrogenic pseudoaneurysm in a patient with a recently placed prosthetic aortic valve and a clinical course precluding repeat open operative procedure. An endovascular approach was used, with placement of a thoracic aorta endograft with temporary cardiac pacing and a double-curved Lunderquist wire to avoid instrumenting the prosthetic aortic valve. At 9 months of follow-up, the patient returned to his baseline activity status, and at 24 months, had no symptoms or signs of infection, and a computed tomography angiogram demonstrated pseudoaneurysm exclusion with no graft migration. (J Vasc Surg Cases 2015;1:283-6.)

The mainstay of treatment for ascending aortic pathology is open repair. Cardiothoracic surgeons have long performed open procedures for ascending aorta aneurysms and type A aortic dissections, often with repair of concurrent aortic valve anomalies (bicuspid and unicuspid valves with stenosis or insufficiency). These procedures require cardiopulmonary bypass and may be unsuitable for some patients. Endovascular approaches for ascending aortic pathology have been described more frequently in recent years, often as case reports or limited case series.[1-3] Most reports of endovascular approaches focus on treatment of ascending aorta aneurysmal disease as well as type A dissections, with less attention to other aortic pathology.

Pseudoaneurysms of the ascending aorta are seen in rare circumstances, typically after cardiac surgery or chest trauma. The potential for rupture or significant hemorrhage mandates surgical intervention. However, open operative procedures for aortic pseudoaneurysms carry a high risk of morbidity, with mortality rates of 41% to 60%.[4,5]

Endovascular approaches to ascending aortic pseudoaneurysms (AAPs) are varied. Septal occluder devices have

been used in a few cases[6,7]; however, complications, including device embolization, have been reported.[8] Endograft placement for AAPs has also been described in case reports[9-11]; yet, complications such as graft migration,[12] ventricular perforation, or pseudoaneurysm formation have been reported,[3] and technical approaches vary significantly. We discuss a unique case of endograft exclusion of an iatrogenic AAP in a patient with a prosthetic mechanical aortic valve and the techniques that led to successful treatment. The patient presented in this case report consented to the publication of this information.

CASE REPORT

A 60-year-old obese man had undergone a minimally invasive sternotomy with prosthetic aortic valve replacement. His postoperative course was complicated by a cardiac arrest with mediastinal bleeding requiring re-exploration. An anterior ascending aorta injury was found and was repaired primarily. He was discharged home, but returned 10 days later after a syncopal episode and fall with recurrent mediastinal bleeding.

Repeat sternal exploration was performed after computed tomography diagnosed continued anterior aortic bleeding. Purulent fluid was also drained from the pericardium, and cultures were positive for *Escherichia coli* and *Proteus mirabilis*. He was subsequently discharged to a skilled nursing facility but returned in 1 week with wound dehiscence and recurrent bleeding. A sternotomy was once again performed, and the site of aortic bleeding was repaired with biologic glue because the tissue was felt unsuitable for suture retention. A pectoralis major flap was placed in the sternal wound bed. Three subsequent sternal site washouts followed during the next week, and anticoagulation was held. Unfortunately, he once again became hypotensive, with chest pain and evidence on examination of active bleeding, and underwent another mediastinal hematoma evacuation.

The patient was transferred to our hospital on broad-spectrum antibiotic therapy and concern for continued ascending aorta bleeding and infection. He arrived with imaging demonstrating
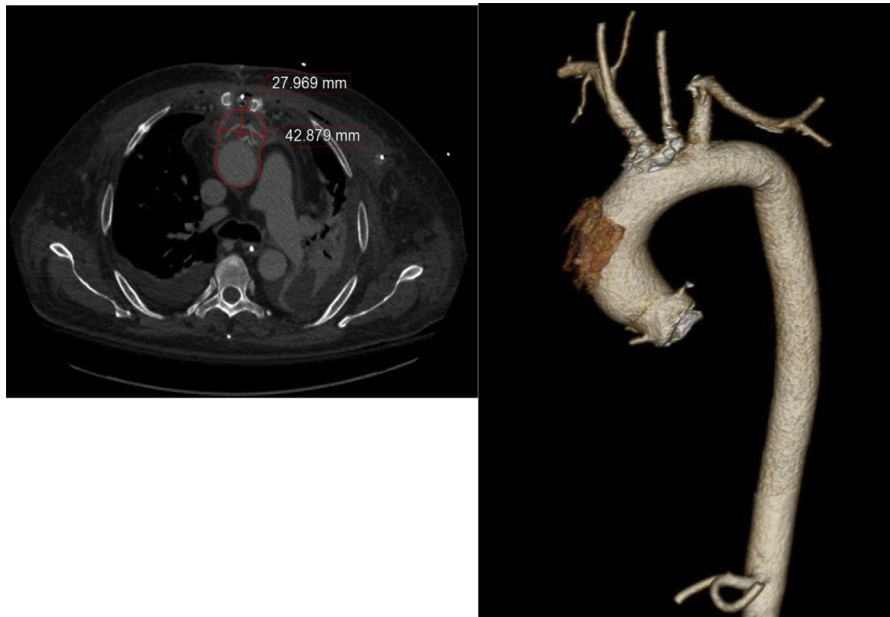
Fig 1. Infected pseudoaneurysm of anterior ascending aorta is seen on **(left)** a computed tomography scan and **(right)** volume-rendered image.

Fig 2. CTAG (W. L. Gore and Associates., Flagstaff, Ariz) device placement in the ascending aorta.

a pseudoaneurysm on the anterior portion of the ascending aorta (Fig 1). Multiple cardiothoracic surgeon consultants judged he was too severely deconditioned to tolerate a repeat open operative intervention requiring cardiopulmonary bypass and ascending aortic graft placement. He was managed initially with pharmacologic hypotension and no anticoagulation, despite the prosthetic aortic valve; however, he had had a recurrent bleeding episode during medical management.

The decision was made to attempt endovascular repair with off-label endograft use for exclusion of the AAP. This was deemed a viable option based on a preoperative computed tomography angiogram showing the ascending aorta was at least 10 cm long. This was confirmed with catheter-based angiogram measurements of the outer wall length; therefore, we chose a 45-mm diameter by 10-cm length CTAG device (W. L. Gore & Associates, Flagstaff, Ariz).

A multidisciplinary team was organized, consisting of a cardiac anesthesiologist, echocardiographer, interventional cardiologist, cardiac surgeon, and vascular surgeons. A temporary pacemaker was placed to provide rapid ventricular pacing for accurate graft deployment. Percutaneous catheterization of the right common femoral artery was performed under ultrasound guidance. A Prostar 10F XL (Abbott, Abbott Park, Ill) device was inserted and deployed with the preclose technique.

After access into the ascending aorta and placement of a Lunderquist double-curved wire (OptiMed, Ettlingen, Germany), a 24F sheath was inserted. Thoracic arch aortography and transesophageal echocardiography showed the prosthetic aortic valve was intact. The Lunderquist wire was advanced and allowed to deflect off of the valve ring. The prosthetic valve was not crossed, reducing the possibility of wire entrapment on the valve and decreasing the risk of damage to the valve leaflets.

A pigtail catheter was passed retrograde from the right brachial artery into the aorta for arch aortography during graft deployment and to facilitate real-time localization of the innominate artery at the point where the brachial and transfemoral wires crossed. A transesophageal echocardiogram was used to confirm ascending aortic diameter measurements and to precisely locate the coronary ostia and the innominate artery orifice.

The CTAG device was advanced into position (Fig 2). A rescue wire was placed from the right brachial artery through the
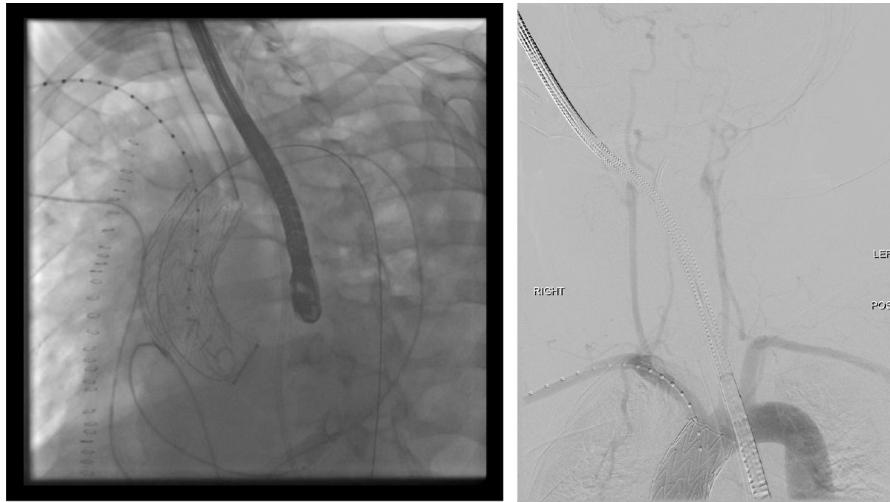
Fig 3. Device deployment directly distal to prosthetic valve **(left)** and completion angiogram with patent arch vasculature **(right)**.

innominate artery and into the ascending aorta in case there was need for snorkel stent placement. Rapid ventricular pacing was briefly induced to ensure a high rate of capture, while simultaneous confirmatory angiography and transesophageal echocardiographic monitoring was performed with apnea (ventilation held). The endograft was then deployed directly above the coronary ostia and at the innominate origin (Fig 3) during rapid pacing, which lasted for 4 to 5 seconds. A standard frame rate of 3 frames/s was used throughout the procedure and contrast injection rates were 15 mL/s for 30 mL (2 seconds). Echocardiographic imaging allowed real-time evaluation of the coronary arteries to confirm our positioning, which was based primarily on angiography. The sheath was withdrawn, and the access site closure was performed with the closure device.

Postoperatively, the patient was restarted on systemic anticoagulation with heparin. He was extubated on postoperative day 4 and transferred out of the intensive care unit on postoperative day 11. He was discharged 22 days after the procedure. Given the placement of a prosthetic endograft in an infected field with *Escherichia coli* and *Proteus mirabilis* returning from cultures, intravenous vancomycin, ceftriaxone, and micafungin were used for a total of 4 weeks.

The patient has been seen in follow-up at 5, 9, 12, and 24 months from surgery with repeat computed tomography. He has no signs or symptoms of infection, has returned to his usual activities, and imaging shows an excluded AAP (Fig 4).

DISCUSSION

Endovascular treatment of ascending aortic pathology is a novel option. One device specifically developed for the ascending aorta has been deployed successfully[13]; however, infrarenal and off-label descending thoracic aortic devices are currently the mainstay of endovascular treatment. Case reports and small case series describe treatment of common ascending aorta pathologies[1-3]; yet, in patients with more uncommon conditions and complicated anatomy, such as this patient with an AAP and a prosthetic aortic valve, strategies for safe device deployment require further exploration.

The nuances of endovascular device placement in ascending aortic pathology are important. Rapid ventricular pacing is used by some,[14] and atrial occlusion for controlled hypotension is used by others.[9] Rapid right ventricular pacing through a pulmonary artery catheter has also been described.[15] Rapid transvenous ventricular pacing is our preferred method and resulted in adequate flow arrest. Using this technique, a 10-cm device was landed precisely between the coronary ostia and the innominate origin.

Techniques to protect previously placed prosthetic aortic valves while placing an ascending aortic endograft are less well known and deserve focused attention. Manipulating a large-caliber endovascular deployment system in the ascending aorta requires a stiff wire for tracking while in close vicinity to the aortic valve. Wire entrapment is therefore a major concern. Techniques to avoid wire entrapment have been described in the interventional literature, specifically when passing across prosthetic valves for left ventricle pressure measurement.[16] Wire entrapment has been reported when passing through native valves while placing hemodialysis catheters[17,18] and during attempts at paravalvular leak repair after prosthetic valve placement.[19] Ventricular complications, such as cardiac perforation or ventricular pseudoaneurysm, have also been reported after endovascular wire manipulation within the heart.[3] In this case, a double-curved Lunderquist wire provided adequate stiffness while allowing deflection off of the prosthetic valve in a limited working zone. Without crossing the valve, the chance of wire-related valve dysfunction and ventricular complications were reduced.

Other techniques used in this case included percutaneous access to avoid the sternum and obtaining a second access for arteriography from the right brachial artery. Transesophageal echocardiography was essential for real-time assessment of guidewire location, endograft positioning, and prosthetic valve function. Careful selection of a device with an adequate working length and a short nosecone is necessary. In this case, the short tip of the
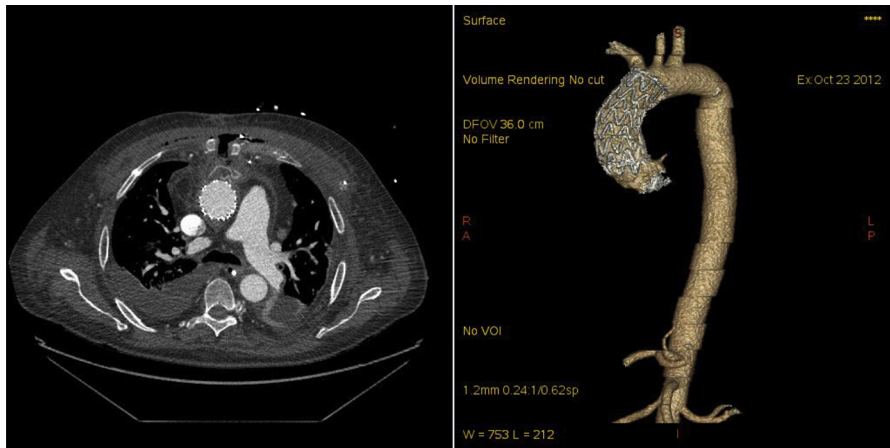
Fig 4. Follow-up **(left)** computed tomography scan and **(right)** volume-rendered image.

W. L. Gore delivery system offered a distinct advantage over other devices, given the mechanical valve anatomy.

The skills of many subspecialties were used, with involvement of vascular surgery, echocardiography, interventional cardiology, cardiac anesthesia, and cardiac surgery. This is the same team approach that has been successful in transcatheter aortic valve implantation in the Placement of Aortic Transcatheter Valves (PARTNER) study.[20] Extended antibiotic therapy, with guidance from infectious disease specialists, was also a key component to achieving adequate long-term results, with the caveat that close follow-up will continue to be essential given placement of a prosthetic material in an infected field.

CONCLUSIONS

AAPs pose significant treatment challenges, particularly in patients with clinical comorbidities limiting open intervention. Certain technical considerations can guide safe deployment of ascending aortic stent grafts in these challenging patients.

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