Endovascular repair of ascending aorta pseudoaneurysm post-extracorporeal membrane oxygenation cannulation during pulmonary transplant

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ABSTRACT

We demonstrated an endovascular technique excluding an ascending aorta pseudoaneurysm using an aortic extension. A 32-year-old woman, 3 years after lung transplantation with extracorporeal membrane oxygenation presented with an ascending aortic pseudoaneurysm. Vascular surgery was consulted after open repair was deemed high risk. An aortic extension stent graft was placed in a hybrid operating room with the aid of intraoperative transesophageal echocardiography. Ascending aorta pseudoaneurysms are complex and life-threatening complications. Traditional repair involves high surgical and anesthetic risks whereas endovascular treatment is technically feasible. (J Vasc Surg Cases Innov Tech 2023;9:101262.)

Keywords: Endovascular repair; Transesophageal Doppler echocardiography; Ascending aorta pseudoaneurysm; ECMO; Lung transplant

Ascending aorta pseudoaneurysms pose clinical and technical challenges. Originating from traumatic, infectious, or iatrogenic causes, the standard of care implies ascending aorta substitution with cardiopulmonary bypass, imposing high cardiovascular, surgical, and anesthetic risks.[1–3] Endovascular treatment decreases these risks; however, it brings technical difficulties given the localization.[1,3-5] Aortic diameter, delivery systems, nose-cone length, proximity to the heart, and high blood pressure make stent deployment problematic.[3] We present an iatrogenic ascending aorta pseudoaneurysm after extracorporeal membrane oxygenation (ECMO) for pulmonary transplant treated with an aortic cuff via left axillary artery (LAA).

The presented case has the patient's written consent to publish their case details.

CASE REPORT

A 32-year-old woman 3 years after lung transplantation presented a new computed tomography finding in routine follow-up: an asymptomatic ascending aorta pseudoaneurysm. Severe interstitial lung disease (ILD) secondary to Sjögren's syndrome progressed to pulmonary hypertension and recurring pneumonias. In September 2019, she underwent lung transplantation with intraoperative central ECMO.

With this computed tomography finding, the patient was admitted, and computed tomography angiography was obtained demonstrating a pseudoaneurysm of the anterior wall of the ascending aorta measuring 25 × 37 × 31 mm, with a 10-mm defect distancing 30 mm from the coronary arteries and 33 mm from the brachiocephalic trunk (BCT) (Fig 1). The patient had no physical findings and denied related symptoms (pulsatile masses or compression syndromes). After multidisciplinary deliberation and exclusion of infection, endovascular repair was elected because of the risks associated with a rethoracotomy, cardiopulmonary bypass, and aortic substitution in an immunosuppressed patient. Nonoperative treatment was considered too risky given the location and size of the defect, the late onset, and the feasibility of endovascular repair.

The patient's ascending aorta measured 29 mm in diameter. Limitations related to endovascular devices for treatment of the ascending aorta with no ectasia and the potential hazard of temporary occlusion of a common carotid artery we elected an aortic cuff extension 34 × 42 mm [Cordis Incraft aortic cuff 34 × 42 mm (Cordis)]. Aortic growth was pondered when choosing a graft size knowing the relative stability of zone 0 diameters from ages 30 to 55, the survival of Sjögren-ILD patients and the survival for double-lung transplant patients owing to Sjögren-ILD.[6,7] This stent graft would ensure exclusion of the false aneurysm while preserving coronaries and the BCT without physician modifications (necessary in grafts >50 mm). The 16F

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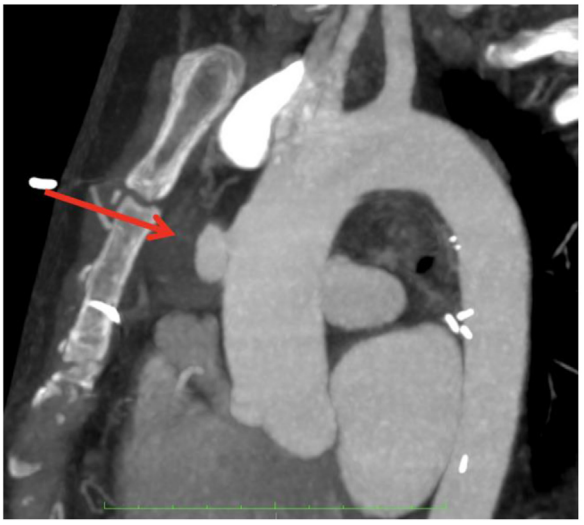

Fig 1. Sagittal view of the pseudoaneurysm in the ascending aorta and its close relations to right brachiocephalic trunk (BCT) and aortic valve.

Fig 2. Nosecone trimming: physician modification shortening.

shaft permitted delivery through the LAA cutdown. The long nosecone hindered adequate positioning without heart injuries; so, we shortened it as illustrated in Fig 2.

The patient was placed under general anesthesia in a hybrid operating room. Access was gained via infraclavicular LAA cutdown and an ultrasound-guided catheterization of the right axillary artery (RAA) with a 5F short sheath. RAA catheterization allowed a closed-arm patient setup thus increasing angulation range of the radioscopy. A 4-cm floppy-tip Lunderquist guidewire was positioned in the left ventricle via LAA; the short tip reduces aortic valve or ventricle lesions and allows adequate support. The ascending aorta was catheterized via RAA with a hydrophilic 0.035″ for BCT visualization and bailout revascularization if necessary. Intraoperative transesophageal echocardiography (TEE) confirmed the aortic diameter, and the distance

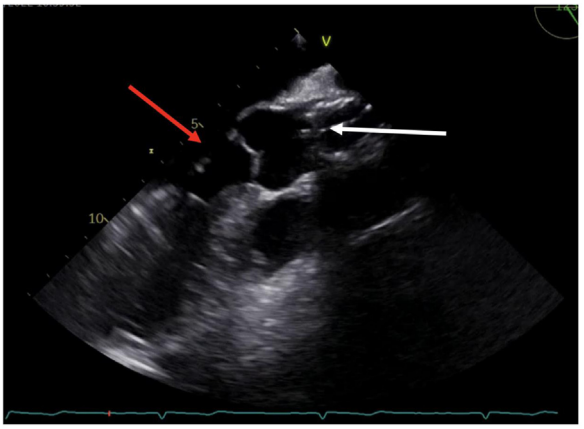

Fig 3. Stent graft delivery seen by transesophageal echocardiography (TEE). White arrow depicts the stent graft delivery system (white arrow) in real time securing distance from the aortic valve (red arrow) and coronary arteries proximally and brachiocephalic trunk (BCT) distally. It also aids in confirmation of pseudoaneurysm exclusion.

from coronary arteries of the visualized the false aneurysm. Stent graft placement simultaneously guided by TEE and fluoroscopy permitted safe deployment (Fig 3). Control angiography demonstrated no leakage and TEE confirmed absent Doppler detection in the false aneurysm (Fig 4).

The postoperative course was unremarkable. The patient was discharged home on postoperative day 4 with no complications. Control computed tomography angiography verified adequate seal with complete false aneurysm exclusion (Fig 5).

DISCUSSION

Common causes of aortic pseudoaneurysms are infections or trauma.[2,8,9] In our patient, however, the probable cause was iatrogenic: central ECMO cannulation for a pulmonary transplant. Standard treatment involves substitution of the ascending aorta, cardiopulmonary bypass, extracorporeal circulation, and cardiac arrest. Considering the patients afflicted by this illness, such procedures may be prohibitive[10,11]; after multidisciplinary discussion, open repair was deemed high risk.

Ascending aortic pseudoaneurysms pose a procedural challenge bearing in mind the absence of approved endovascular devices for the ascending aorta.[3,4,10-12] Consequently, technical issues such as shaft size and flexibility, nosecone length and adequate support for precise deployment had to be contemplated.

The ascending aortic diameter of our patient was 29 mm with healthy proximal and distal necks. The distance between the origin of the coronary arteries and the BCT was of 60 mm, making off-the-shelf thoracic graft options unfeasible owing to their length. Avoiding physician modifications, we chose an abdominal aortic endograft cuff.

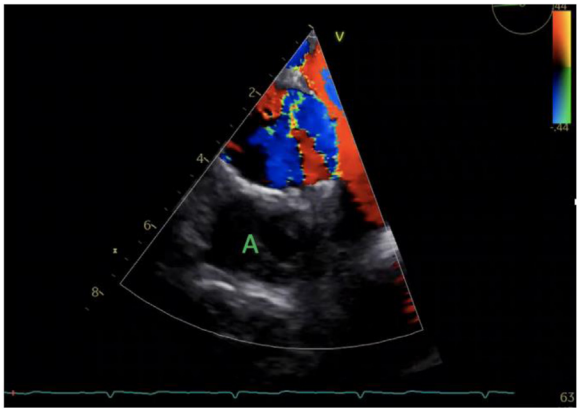

Fig 4. Exclusion of the pseudoaneurysm confirmed with no flow in transesophageal echocardiography (TEE). (A) Pseudoaneurysm without Doppler detection.

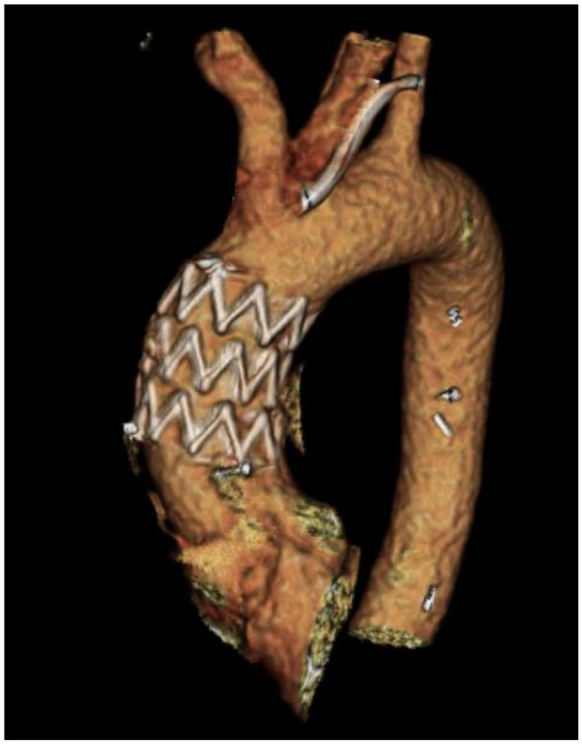

Fig 5. Control computed tomography angiography demonstrating complete exclusion of the pseudoaneurysm.

Short shafts also imposed a challenge: even with an iliac conduit, adequate zone zero positioning would be troublesome.[1] For this procedure, the LAA cutdown was used for endograft placement given the absence of atherosclerosis of the arch, the favorable angulation of the left subclavian artery to the aorta, and the maintenance of continuous blood flow to the carotid arteries during deployment. Knowing the 5-mm diameter of the LAA, the lowest profile shaft available (a high-complexity public hospital in São Paulo, Brazil) for use was the 16F aortic extension cuff.

The size of the nosecone of the aortic devices, seeing they are not manufactured for zone zero deployment, are long varying from 6 to 8 cm in length.[1,4,11] To prevent injury to the aortic valve, papillary muscles, or left ventricle the nosecone was manually trimmed as demonstrated in Fig 2 with the aid of a scalpel. The now blunt nosecone allowed for a smooth entry into the LAA and safe crossing of the aortic valve without an introducer sheath. The original sleek tip was 8 cm in length, which would risk left ventricle lesions.

Simultaneous fluoroscopic and intraoperative TEE was crucial for safe placement of guidewires, verification of the aortic diameter and length, and precise deployment visualization guaranteeing proximal and distal landing zones for the 34 × 42 mm aortic cuff. A transient hypotension (systolic blood pressure <60 mm Hg) was obtained with vasodilators to avoid distal dislocation of the stent.[13] If suitable hypotension were not obtained, pharmacologically induced transient cardiac arrest (with the use of adenosine) or rapid ventricular pacing would have been contemplated.[14]

Postoperative surveillance will be maintained through clinical follow-up, annual TEE, and computed tomography angiography alongside the cardiology and pulmonary transplant teams.

CONCLUSIONS

Ascending aorta pseudoaneurysms are a life-threatening condition where traditional treatment may itself result in death considering the operative and anesthetic risks. With the diffusion of complex procedures such as coronary artery bypass and the evolution of ECMO worldwide due to the coronavirus disease 2019 outbreak, this complication may become more common. Endovascular approach to exclude ascending aorta pseudoaneurysm with aortic cuff extensions is feasible especially when utilizing intraoperative TEE for secure placement. Considering operative risks, it is a viable option in high-risk patients avoiding resternotomies or remediastinotomies, cardiopulmonary bypasses, and induced cardiac arrests with open aortic substitutions. Studies with longer follow-ups and clinical trials are needed to validate this therapy. The technical challenges regarding the endovascular devices available for this use have been reported for >20 years.[15]

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