Endovascular Repair of Ascending Aortic Pseudoaneurysm: Technical Considerations of a Common Carotid Artery Approach Using the Zenith Aortic Cuff Endograft

Peter H. Lin, MD¹,3; Panagiotis Kougias, MD¹,3; Tam T. Huynh, MD¹,3; Joseph Huh, MD²,3; and Joseph S. Coselli, MD²,4

Divisions of ¹Vascular Surgery & Endovascular Therapy and ²Cardiothoracic Surgery, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston, Texas, USA. ³Michael E. DeBakey VA Medical Center and ⁴Texas Heart Institute at St. Luke’s Episcopal Hospital, Houston, Texas, USA.

Purpose: To present a technique for endovascular treatment using Zenith aortic cuff extenders delivered via a left common carotid artery (CCA) approach in a patient with a large symptomatic ascending aortic pseudoaneurysm.

Case Report: A 78-year-old man with recent stroke developed worsening exertional dyspnea and chest pain 4 years following coronary artery bypass grafting. Imaging demonstrated a bovine arch and an 8×12-cm ascending aortic pseudoaneurysm that was compressing the pulmonary arteries. The treatment strategy was to deliver a Zenith aortic cuff to seal the ascending aortic pseudoaneurysm via a left CCA approach. With the patient under general anesthesia, the left CCA was exposed and a transverse arteriotomy was made to introduce the Zenith aortic cuff sheath; the distal CCA was clamped to prevent catheter-related embolization. With its nosecone removed, a 32×36-mm Zenith aortic cuff was delivered to the ascending aorta via the left CCA and positioned under transient cardiac arrest initiated with intravenous adenosine. A total of 3 Zenith aortic cuffs were placed in the ascending aorta to successfully exclude the pseudoaneurysm. The patient tolerated the procedure well; follow-up imaging showed successful pseudoaneurysm exclusion without endoleak.

Conclusion: Ascending aortic pseudoaneurysm is a formidable clinical challenge due in part to the significant operative stress in a conventional surgical repair, as well as limited endovascular treatment options. Because there are no approved endovascular devices for ascending aortic aneurysm repair, clinicians may have to rely on endograft components designed for abdominal aortic aneurysms to treat lesions in the ascending aorta.

Key words: endovascular repair, ascending aorta, aortic pseudoaneurysm, common carotid artery, stent-graft, cuff extenders

Pseudoaneurysm of the ascending aorta is an uncommon and surgically challenging problem. Traditional operative repair involves cardiopulmonary bypass with ascending aortic replacement under hypothermic circulatory arrest, which is associated with high operative morbidity and mortality.¹,² Although endovascular exclusion of an aortic...
pseudoaneurysm using an endograft may represent a less invasive treatment option, such a treatment modality similarly possesses its own therapeutic challenges. Since the Food and Drug Administration (FDA) presently has not approved an endograft device for ascending aortic application, utilization of commercially-approved devices, which are intended for abdominal aortic aneurysm, is associated with certain limitations. In addition, delivery of an endograft device to the ascending aorta can be challenging from the conventional femoral artery access. Moreover, the high blood flow in the ascending aorta may render precise endograft deployment difficult. We present a patient with an iatrogenic ascending aortic pseudoaneurysm that occurred 4 years following a coronary artery bypass graft (CABG) procedure. The lesion was successfully treated with endovascular exclusion via a left common carotid artery (CCA) approach.

CASE REPORT

A 78-year-old man developed progressive worsening of exertional dyspnea and chest pain 4 years following CABG. Computed tomography (CT) of the chest demonstrated an 8-×12-cm ascending aortic pseudoaneurysm that was compressing the pulmonary arteries (Fig. 1A). An aortogram (Fig. 1B,C) revealed a bovine arch and an ascending aortic pseudoaneurysm arising from an aortic cannulation site from the prior CABG. Because of his medical comorbidities (chronic obstructive pulmonary disease and recent stroke), he was deemed a poor candidate to undergo an open surgical repair of his ascending aortic pseudoaneurysm. The total length of the ascending aorta that was amenable to endograft implantation was ~6 cm measured from the orifice of the coronary bypass graft to the innominate artery. The ascending aortic diameter was 30 mm based on CT measurement. The origin of this ascending aortic pseudoaneurysm was located in the mid segment of the ascending aorta. The treatment strategy was to deliver an endovascular aortic cuff (Fig. 2) to seal the ascending aortic pseudoaneurysm via a left CCA approach. A carotid duplex ultrasound and carotid angiogram were performed to confirm that the left carotid artery system was relatively free of disease and amenable to endovascular access.

The patient was taken to an operating suite equipped with a fluoroscopic imaging unit (OEC 9800; GE Medical Systems, Milwaukee, WI, USA). With the patient under general anesthesia, a right femoral access was established using a 6-F introducer sheath (Boston Scientific, Natick, MA, USA). The left CCA was exposed via a neck incision along the anterior border of the sternocleidomastoid muscle. An ascending aortogram was performed via a 5-F pigtail catheter delivered from the femoral
access. A transverse arteriotomy was opened in the exposed CCA, and the Zenith aortic cuff sheath was introduced. A 0.035-inch Bentson guidewire (Boston Scientific) was placed in the ascending aorta via the left CCA sheath. This wire was changed to a 0.035-inch Lunderquist Extra-stiff guidewire (Cook Inc, Bloomington, IN, USA) under fluoroscopic guidance. Transesophageal echocardiography (TEE) was used to visualize the ascending aortic pseudoaneurysm. The distal CCA was clamped to prevent potential catheter-related embolization. With the 32-×36-mm Zenith aortic cuff device delivered to the ascending aorta via the left CCA, it was apparent that the device nosecone was too long to allow the aortic endograft to be positioned adequately in the ascending aorta (Fig. 3A). The aortic cuff was removed from the sheath, and the nosecone was trimmed off so the device could be properly delivered to the ascending aorta via a left CCA (Fig. 3B). With transient cardiac arrest initiated as needed using intravenous adenosine, 3 partially overlapping Zenith aortic cuffs were placed in the ascending aorta to successfully exclude the pseudoaneurysm, as demonstrated on the completion angiogram (Fig. 3C). The introducer sheath was removed, and the carotid arteriotomy was closed with 3 5–0 Prolene interrupted sutures. The patient tolerated the procedure well and without complications. The follow-up CT scan (Fig. 3D) at 1 month showed successful pseudoaneurysm exclusion without endoleak.

**DISCUSSION**

Common causes of aortic pseudoaneurysm include traumatic or mycotic etiologies. In our patient, however, we postulate that his pseudoaneurysm was an iatrogenic complication due to cannulation of the ascending aorta during the prior CABG procedure. In patients with acceptable operative risk, the surgical treatment of choice is mediastinotomy with direct aortic reconstruction. Such a treatment approach, however, would have posed a prohibitive risk in our symptomatic patient due to his comorbidities. As a result, an endovascular strategy was considered. Since there is no FDA-approved device for ascending aortic placement, the only endovascular option involved an off-label use of aortic cuff endografts as a means of excluding the ascending aortic pseudoaneurysm. In planning for this endovascular procedure, several technical concerns were considered.

The first issue relates to which aortic cuff endograft should be used. The ascending aortic diameters proximal and distal to the pseudoaneurysm in our patient were 28 and 29 mm, respectively. Consequently, an Ancurex or Excluder aortic cuff would not have been adequate (maximum diameters of 28 and 28.5 mm, respectively). As a result, the only suitable aortic cuff for our patient was a Zenith aortic device, which had a wide range of diameters up to 36 mm. We chose a 32-mm cuff for ascending aortic implantation, but we had to place 3 of them to fully exclude the pseudoaneurysm since endoleak was detected following the first and second cuff implantations. We postulate that the high aortic shear stress in the ascending aorta made it necessary to use 3 partially-overlapping aortic cuff endografts to fully exclude this aortic pseudoaneurysm.

The second technical consideration was to determine which artery should be accessed for endograft deployment, since gaining access to the ascending thoracic aorta poses a particular challenge. Previous reports have
documented the feasibility of creating an iliac conduit through which an aortic cuff endograft is deployed to repair aneurysms of the descending thoracic aorta.\(^{3-6}\) However, such an approach may not be applicable for ascending aortic endograft placement. All commercially available aortic cuff devices (Excluder, AneuRx, and Zenith) have varying shaft lengths ranging from 55 to 65 cm, which are insufficient for standard femoral delivery to the ascending aorta even if an iliac conduit were created. Therefore, we had to consider deploying an aortic cuff via an aortic branch vessel such as a carotid or subclavian artery.

Rayan and colleagues\(^7\) recently reported a case of Excluder aortic cuff deployment via a left axillary artery cutdown, through which the authors delivered a 28.5-mm-diameter cuff in a bareback fashion over a stiff guidewire and successfully deployed it in the ascending aorta to exclude a mycotic aneurysm of the ascending aorta. In our patient,
stent-graft deployment via a left axillary or subclavian artery would temporarily occlude the left internal mammary artery, which provided the only inflow to existing coronary bypass grafts. Thus, severe myocardial ischemia could have occurred in this scenario. Because of the bovine aortic arch, we postulated that deploying an aortic cuff endograft via the right CCA would lead to transient occlusion of the left CCA by the introducer sheath owing in part to the takeoff angle of the left CCA from the innominate artery. This would undoubtedly increase the risk of neurological complications. As a result, we chose the left CCA to deliver the aortic endograft device because it was least likely to incur either cardiac or neurological sequelae.

The last technical consideration in our patient relates to device deployment. The relatively long nosecone of the Zenith endograft had to be trimmed so that the aortic cuff could be more proximally positioned in the ascending aorta. To facilitate device deployment, we pharmacologically induced transient cardiac arrest, which significantly reduced aortic pulsation and enhanced device deployment accuracy. Several authors have previously reported the beneficial effect of adenosine in inducing transient cardiac arrest when deploying an ascending aortic endograft. 5,6,8,9

**Conclusion**

Because there are no approved endovascular devices for ascending aortic aneurysm repair, clinicians may have to rely on endograft components designed for abdominal aortic aneurysms to treat lesions in the ascending aorta. With careful planning of the treatment strategy, as well as appropriate patient selection, successful outcomes can be achieved using an endovascular approach to treat ascending aortic pseudoaneurysms.

**REFERENCES**