A challenging double bubble thoracic aortic and proximal subclavian aneurysm treated via transapical access

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ABSTRACT

This case report describes a patient with a distal aortic arch and left subclavian artery aneurysm who was considered unsuitable for open surgical repair because of comorbidities and previous bypass surgery. Inadequate peripheral access precluded standard transfemoral thoracic endovascular aortic repair. Nonetheless, successful endovascular repair was possible via transapical access using the new Gore cTAG deployment mechanism, which allowed precise antegrade stent graft deployment in a short proximal neck. (J Vasc Surg Cases and Innovative Techniques 2020;6:80-3.)

Keywords: TEVAR; Aortic aneurysm; Transapical access; Subclavian aneurysm; Stent graft

Thoracic endovascular aortic repair (TEVAR) is the preferred treatment for aortic disease involving the descending aorta and distal aortic arch, especially in patients with significant comorbidity.[1] However, a number of anatomic factors, the most important being proximal neck length and adequate peripheral access, limit the applicability of endovascular repair. In patients who are unfit for open repair, several adjunctive operative techniques can be used to overcome these anatomic constraints. Extra-anatomic revascularization and intentional coverage of the left subclavian artery (LSA) is common practice to create sufficient proximal neck length.[2] In case the femoral artery is unsuitable for access (even after percutaneous transluminal angioplasty), we prefer to evaluate a retroperitoneal access using either direct or via a conduit. In case the common iliac arteries are also extensively calcified and stenosed, the transapical approach is our preferred next route. This approach is associated with specific technical difficulties, because it requires antegrade stent graft delivery,[3] whereas all commercially available stent grafts have been developed for retrograde deployment. This potentially leads to problems during deployment from tip to hub, causing suboptimal proximal positioning. Recently, the deployment mechanism of the Gore conformable TAG stent

graft (cTAG, W. L. Gore & Associates, Flagstaff, Ariz) has been modified. The stent graft now expands first at the distal end, then proximally. Use of this stent graft allows controlled deployment, even in the circumstance of transapical, antegrade access. This case report describes how the abovementioned techniques were used to treat a patient who was considered unfit for open repair, but with multiple challenging anatomic characteristics precluding standard TEVAR. The patient provided informed consent for the use of his data for this article.

CASE REPORT

The patient is an 81-year old man, referred for a large descending thoracic aortic aneurysm (Fig 1). Owing to his age and past medical history, which included hypertension and a coronary artery bypass graft (with a left internal mammary artery [LIMA] graft), endovascular repair was considered preferable. Standard preoperative workup with computed tomography angiography (CTA) showed a double bubble atherosclerotic aneurysm involving the distal aortic arch and proximal LSA, with maximum diameters of 6.0 cm and 6.7 cm, respectively (Fig 1), and severely calcified and stenosed iliofemoral arteries, precluding transfemoral access (Fig 2). The suspected etiology of the atypical proximal subclavian artery aneurysm was degenerative by atherosclerosis. Predominantly due to the extensive and generalized atherosclerosis throughout the patient. CT scanning did not demonstrate a postdissection etiology or any signs (also clinically) of postinfectious or inflammatory origin. To determine the treatment options with respect to the LSA a coronary angiography and magnetic resonance angiography of the circle of Willis were performed. These studies showed a patent LIMA to left anterior descending (LAD) artery as well as patent saphenous vein graft, making an LSA bypass preferable over LSA transposition. There was a complete circle of Willis with adequate communication between the left and right hemispheres, allowing safe carotid clamping, although the left internal carotid and right vertebral artery were occluded.

In our practice we routinely use an electroencephalogram (EEG) as well as transcranial Doppler ultrasound in all cases of LSA transposition or bypass (in presence of an adequate
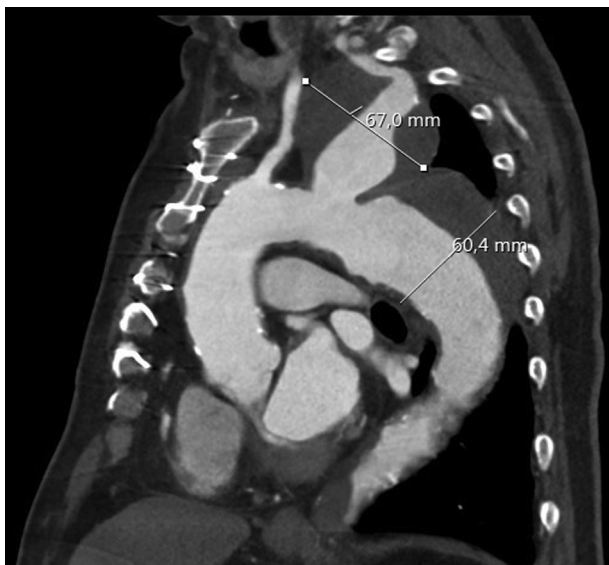
Fig 1. Multiplanar reconstruction of the patient computed tomography angiography (CTA) showing a large double bubble aneurysm involving the proximal descending aorta and left subclavian artery (LSA).

Fig 2. Three-dimensional reconstruction of computed tomography angiography (CTA) showing a severely calcified iliofemoral tract bilaterally.

acoustic window). Although intraoperative shunting is technically not possible (owing to the small arteriotomy), we do use the neurophysiologic monitoring intraoperatively to inform us about the distal consequence of temporary occluding the left common carotid artery (LCCA). In case of a decrease in transcranial Doppler ultrasound of more than 50% at the ipsilateral middle cerebral artery and/or EEG changes, arterial blood pressure is immediately increased medically to a mean of 100 mm Hg to counteract the decrease. In case no changes are noted at all, blood pressure is not altered. Such an increase in blood pressure only when indicated prevents inadvertent anastomotic leakage at the sometimes fragile LSA.

Operative procedure. The operation was performed as a single-stage procedure under general anesthesia in a hybrid operation room. Intraoperative cerebral monitoring was done with an EEG alone because there was no useable transcranial Doppler window. First, the LCCA-LSA bypass was created according to the method that has been published previously.[2] A transverse left cervical incision was made to expose the LCCA, the LSA was prepared infraclavicular to prevent inadvertent injury to the patent LIMA, and a tunnel was created. Heparin was administered (5000 IE), the LSA was clamped and an anastomosis was made with a 7-mm Dacron prosthesis (Vascutek Gelweave, 15 cm × 7 mm; Vascutek, Inchinnan, UK). The graft was tunneled under the left clavicula, the LCCA was clamped, blood pressure was increased medically to a mean of 100 mm Hg, and the proximal anastomosis was made.

Placement of an Amplatzer vascular plug (AVP; Abbott Vascular, Santa Clara, Calif) in the distal neck of the LSA aneurysm was attempted, but stable positioning proved to be impossible using access from the distal LSA, so it was then accessed from the groin. Although femoral access was
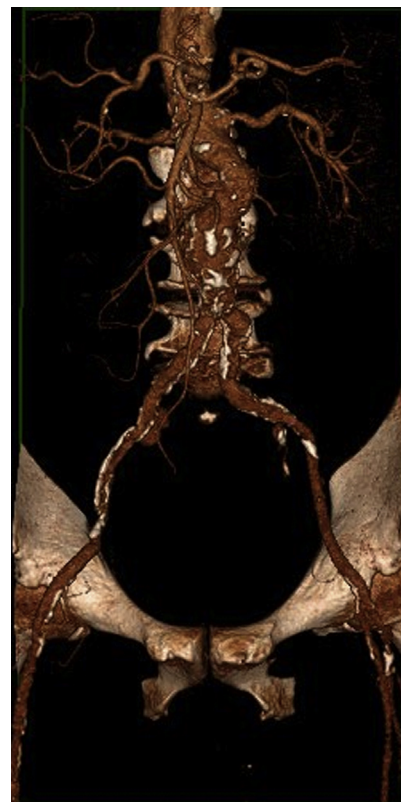
insufficient for a 24F introducer of the TEVAR device, the diameter was wide enough for the 8F sheath of the AVP. Again, positioning was technically challenging, but deployment was successful after using a snare wire from the left brachial artery to ensure stability of the guiding sheath.

The next step was transapical stent graft deployment, which was performed according to previously described steps.[3] Single lung ventilation was established, and a small left anterolateral thoracotomy was made to expose the left ventricular apex. The edges of the pericardium were suspended to the thoracic wall with single sutures. A double purse string suture (Prolene 3-0 on felt pledgets) was made on the apex. A 9F sheath, a guidewire and then a catheter were used to position a stiff guidewire from the transapical access down to the abdominal aorta. Next, the 9F sheath was exchanged for a 24F delivery sheath, followed by antegrade advancement of the stent graft (Gore cTAG, diameter 37 mm, length 20 cm). Angiography was made and the stent graft was positioned (Fig 3, *A*), and deployed just distal of the LCCA, with good result on control angiography (Fig 3, *B*). During this part of the procedure, there were notable electrocardiogram changes for which an angiography of the LIMA graft was done, which showed adequate anastomosis and flow in the LIMA, so no further action was taken, and the operation was completed according to standard required steps.

Postoperative course. Postoperatively, medical treatment with daily acetylsalicyl acid (80 mg) was immediately restarted

Fig 3. Angiography images of stent graft position before deployment **(A)** showing the sheath from the trans-apical access, and the through-and-through guidewire through the aortic valve down to the distal descending aorta, and after deployment **(B)** showing the stent graft position just distal to the left common carotid artery (LCCA), exclusion of the left subclavian and aortic aneurysm without evidence of endoleak, and patent left internal mammary artery (LIMA) and left subclavian bypass grafts.

as per protocol (although in this patient it was later switched to apixaban (5 mg twice daily) owing to recurrent episodes of atrial fibrillation). The postoperative course was complicated by an episode of ventricular fibrillation requiring reanimation on postoperative day 6, without any neurologic sequelae. Coronary angiography was repeated and showed a thrombotic occlusion of the distal LAD (but patent LCCA-LSA bypass), which was managed conservatively. A two-chamber implantable cardioverter-defibrillator was implanted as secondary prevention. Postoperative CTA showed good stent graft position, without evidence of endoleak or other stent graft related complications (Fig 4). and the patient was dismissed home in good clinical condition on postoperative day 17.

A control CTA scan was made 3 months postoperatively, and showed no evidence of stent graft-related complications. It also showed an apical infarction around the distal LAD with closed off collaterals, which makes apical closure the most likely cause for the ischemia seen in the postoperative period. Alternatively, the multiple attempts to position the wire into the distal subclavian artery for the Amplatzer plug, with accidental entering of the proximal LIMA graft with the floppy wire, may have caused distal embolization of the apical LAD.

DISCUSSION

Several aspects of the described procedure are worth underlining. Most important, accurate stent graft deployment has been mentioned by several groups, to be a challenge during transapical delivery.[3-5] This problem was handled using the unique active control deployment mechanism of the Gore cTAG stent graft.[6] In detail, stent graft expansion occurs in two steps. Removal of the first deployment handle results in gradual deployment of the stent graft to 50% of its diameter, opening from the leading to the trailing end. During antegrade delivery,

this means the part most distal in the aorta opens first. The second step is deployment of the stent graft to 100% of its diameter, from the trailing to the leading end. For antegrade delivery, this means the part of the stent graft that is positioned most proximally in the aorta (in this case, just distal to the LCCA) expands first, which enables accurate positioning in a short proximal neck. A minor remaining drawback to transapical access is that the new angulation control feature of the cTAG stent graft, which allows readjustment of the leading end of the stent graft after expansion to full diameter, is not possible for the proximal sealing zone during antegrade delivery. In our case this led to a minimal bird-beak configuration, which probably also would have occurred during standard TEVAR approach. In fact, the use of a through-and-through or body floss wire, might improve stent graft stabilization in acutely angulated aortic arches.[7,8] Such a body floss wire can be obtained by bringing down, and subsequently out the femoral artery, a stiff guidewire using a snare or lasso. Through a long catheter from apex to groin, the stiff wire can be safely forwarded to allow for gentle pull upon introduction of the stent graft to prevent the stent graft from touching the outer aortic arch curvature, thus also decreasing the risk of distal embolization from debris at the outer curvature.

Maintaining adequate brain perfusion is an important aspect of any procedure involving the aortic arch, and hypoperfusion has been suggested as a cause of periprocedural stroke in TEVAR, although direct evidence is lacking.[9] Although we have previously emphasized the importance of rapid pacing during deployment in the arch,[3] accurate positioning now proved possible without it, so even a brief episode of hypotension could be

Fig 4. Volume-rendering image of postoperative computed tomography angiography (CTA) scan, showing correct stent graft position without evidence of complications apart from a minimal bird beak, and adequate contrast in the bypass between left common carotid artery (LCCA) and left subclavian artery (LSA).

avoided. Of note, although hypoperfusion is thought to play a role in the risk of stroke, catheter and wire manipulation in the arch, leading to embolization of atherosclerotic debris,[10] are generally believed to be the principal cause of periprocedural stroke. Theoretically, there is a relatively short distance from access site to lesion to be treated and a relatively long length of distal guidewire control when using transapical access, which might aid to minimize the amount of catheter and wire handling.

CONCLUSIONS

This case report shows that the new Gore CTAG deployment mechanism enables controlled antegrade stent graft deployment for transapical TEVAR, even in the presence of challenging anatomic features.

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