Concomitant true and false lumen "parallel thoracic endovascular aortic repair" as an endovascular alternative to open arch/descending aortic reconstruction for chronic DeBakey type I dissection with aneurysmal degeneration

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ABSTRACT

A 77-year-old woman presented with symptomatic thoracic aortic aneurysm within a dissected thoracoabdominal aorta distal to a previous Dacron ascending aortic replacement. She was not a candidate for open repair and had no proximal landing zone for conventional thoracic endovascular aortic repair (TEVAR) resulting from dissection extension into the brachiocephalic vessels. A concomitant parallel graft true and false lumen TEVAR was performed from the distal aortic arch to diaphragm. Follow-up imaging demonstrated successful exclusion of the false lumen aneurysm and successful protection of the true lumen with the adjacent parallel TEVAR device. (J Vasc Surg Cases and Innovative Techniques 2019;5:557-60.)

Keywords: Endovascular; Stent; Dissection; Aorta; Aortic arch

Residual chronic DeBakey type I dissection distal to an ascending repair with false lumen (FL) aneurysmal degeneration would classically be treated with open arch reconstruction or left chest open thoracic repair, depending on the site of the aneurysm and the diameter of the arch. This presents significant therapeutic challenges when open surgery is contraindicated because of the physiologic impact of the operation. Total endovascular arch repair has had promising results, but device unavailability, technical complexity, and patient anatomy limit its utility in common practice. Also, dissection into the brachiocephalic vessels, short/angulated proximal Dacron, mechanical heart valves, and existing coronary bypass artery grafts arising from the ascending aorta can preclude or further complicate this type of repair. We present a case in which concomitant true lumen (TL) and FL thoracic endovascular aortic repair (TEVAR) was performed to treat a patient with a large symptomatic FL aneurysm in a residual type I dissection, providing exclusion of the aneurysm without manipulation of the dissected proximal aortic arch. The patient authorized the disclosure of her case details and images.

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CASE REPORT

A 77-year-old female with emphysema, coronary artery disease, chronic kidney disease (creatinine 2.9), and a history of ascending aortic repair for acute dissection 13 years prior with a subsequent coronary bypass artery graft arising from her Dacron repair 1 year after that procedure now presents with rapid enlargement (6.5-7.8 cm) of her known thoracic aortic aneurysm and mid-back and left flank pain.

Following adequate hydration, computed tomography (CT) angiogram (Fig 1) demonstrated residual dissection beginning at the distal aspect of the Dacron ascending repair, with FL flow from a fenestration at the distal anastomosis and from septal tears within the dissected brachiocephalic vessels. The dissection extended into all arch branches, with extension of the innominate dissection into the axillary artery and extension of the left carotid artery well into the neck. The dissection also extended into the descending thoracic aorta, terminating just above the superior mesenteric artery. With the exception of the celiac artery, arising from the FL, all visceral/renal vessels and the lower extremities were perfused by the TL. A very small (~1 mm) fenestration between the TL/FL was apparent at the level of the celiac artery. The arch and very proximal descending thoracic aorta were not aneurysmal, but given the dissection throughout the arch beginning at the previous Dacron repair, there was no landing zone for conventional TEVAR that would provide cessation of flow to the FL and symptomatic aneurysm.

The patient and our multidisciplinary aortic team all agreed that her advanced age and comorbidities precluded left thoracotomy/descending aortic repair, which would have been our preference in a younger/healthier patient with similar anatomy, as well as hybrid arch repair/antegrade TEVAR.

Procedure. A preoperative spinal drain was placed. Open femoral exposure was performed and wire access was obtained from both sides. The FL was catheterized (Fig 2) from the right femoral access through the small fenestration at the level of the

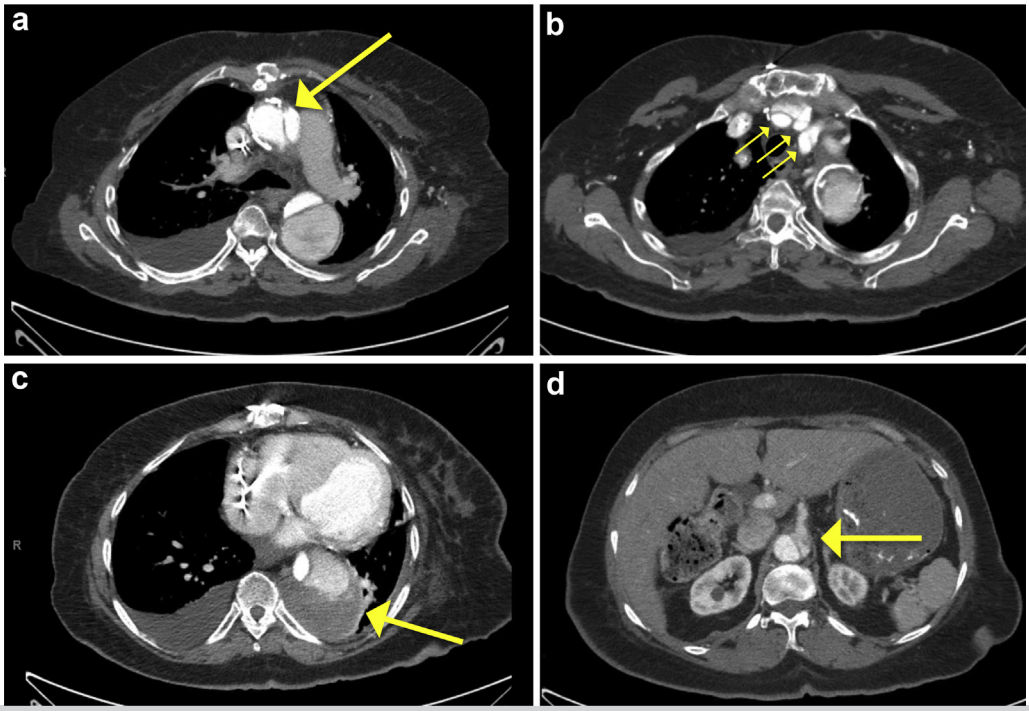

Fig 1. Preoperative computed tomography angiogram **(a)** demonstrating previous ascending aorta Dacron replacement and dissection origin, **(b)** dissection involving aortic arch branch vessels, **(c)** 7.8 cm maximum dilation of descending thoracic aorta, and **(d)** celiac artery supplied by false luminal flow.

celiac artery. Confirmation of the wire traversing the FL and the left femoral wire traversing the TL was obtained with intravascular ultrasound. Both wires were advanced into the arch of the aorta after systemic heparin. To allow purchase and advancement of the 20-Fr FL sheath, right brachio-left femoral access was obtained to allow advancement of the sheath into the distal arch of the aorta.

The total aortic diameter was measured to be 38 mm and an adjacent 28 × 28 × 150 Gore CTAG (W. L. Gore & Associates, Flagstaff, Ariz) devices were deployed in each lumen just distal to the level of the left subclavian. The devices were deployed together, and gentle concomitant ballooning was then performed with a Coda balloon (Cook Medical, Bloomington, Ind). We then deployed a second 28 × 28 × 150 Gore CTAG in each lumen. Because of a longer centerline length, a third CTAG (28 × 100) was required in the FL to provide parallel stents to the level of the diaphragm.

A flush aortogram in the arch of the aorta demonstrated brisk flow through both lumens, with successful exclusion of the FL aneurysm and preserved flow into all visceral vessels. Follow-up CT scan is shown in Fig 3.

DISCUSSION

An isolated hemiarch replacement to the level of the innominate artery remains the most common operation performed for acute type A dissection. This limited replacement specifically in DeBakey type I pathology can leave residual dissection within and distal to the arch. FL patency is an independent risk factor for rate of distal aortic enlargement[1,2] and a predictor of late death and need for distal reintervention,[3] often because of aneurysm.[4] Following type I repair, reoperation rates are reported to be 21% to 39% at 10 years[1,4-6] and residual dissection has been noted in 64% to 90% of patients.[1,3,6,7] An estimated 12% of reoperations are due to aneurysm of the arch, requiring open reconstruction.[4] Even at high-volume aortic centers, these operations carry significant morbidity risk and a 1-year mortality risk of 10%.[8]

Endovascular dissection repair traditionally aims to eliminate FL flow through occlusion of the dominant septal tear with resulting depressurization of the FL. Because of dissection involvement of the aortic arch with the arch branches supplied by FL flow, historically the only solutions for this patient would have been total arch, hybrid arch, or open left chest thoracic aortic reconstruction. Eliminating the necessity for complex arch reconstruction, parallel TEVAR within the TL/FL allows continued flow through both lumens, providing protection from TL compression and sealing above and below the FL aneurysm to alleviate aneurysmal FL wall stress, while preserving flow to the arch branches and any visceral/renal vessels arising from the FL distally. Although data on the long-term efficacy of this approach are lacking, previous reports have supported the safety of endovascular false lumen manipulation and stenting.[9,10]

This technique specifically applies to treatment of residual dissection after previous type I repair and should be applied only to select patients with a nonaneurysmal proximal and distal descending thoracic aorta to provide

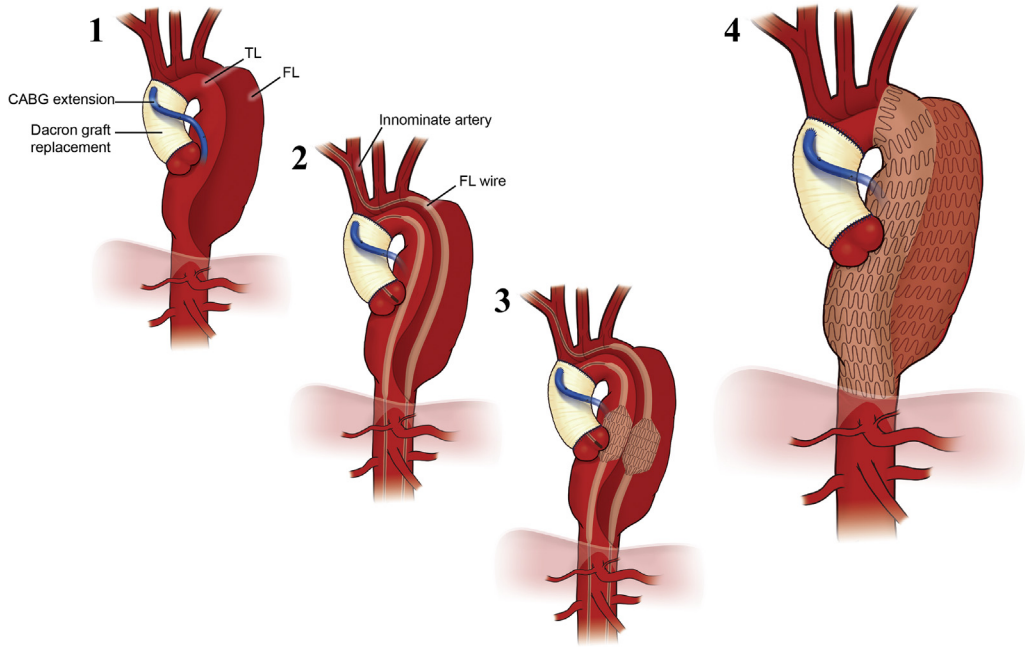

Fig 2. Deployment sequence of concomitant stentgrafts. **1,** Preoperative anatomy including Dacron replacement of ascending aorta with coronary artery bypass graft (*CABG*) extension and dissection involving aortic arch, arch branch vessels, and descending aorta. **2,** Introduction of bilateral femoral access wires into true lumen (*TL*) and false lumen (*FL*) via celiac artery fenestration, with extension of FL wire into innominate artery to obtain through and through R-brachio-L-femoral access. **3,** Simultaneous deployment of true and false lumen stentgrafts. **4,** Fully deployed, seated parallel TL/FL stentgrafts.

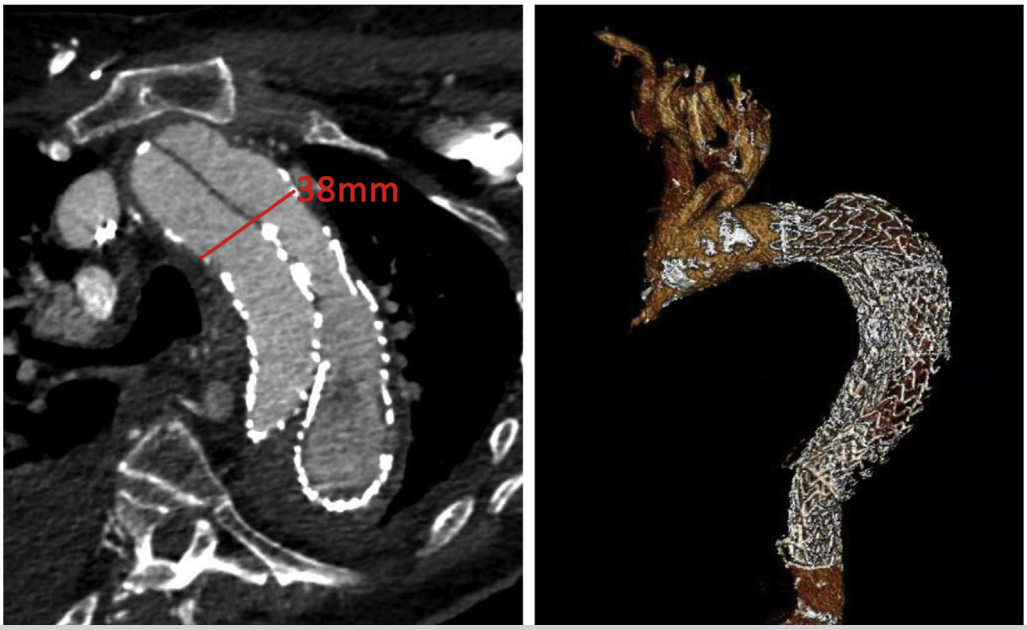

Fig 3. Postoperative computed tomography scan demonstrating parallel true/false lumen devices in place with no evidence of endoleak and exclusion of false lumen aneurysm.

landing zones for the parallel TEVAR grafts. There are no strict sizing criteria, but endograft sizing should allow graft expansion in both lumens and seal within their respective lumens. This patient had a total aortic diameter of 40 mm proximally and 36 mm distally, with TL and FL of equivalent sizes. Here, we achieved good results with 28-mm grafts in each lumen.

Given the often-complex flow dynamics associated with a dissection such as this, consideration should be given to the perfusion of any vessels arising from the TL

and FL once the devices are deployed. In this patient, because the primary flow into the dissection was within the arch and the brachiocephalic vessels were perfused from both the TL and FL, we felt that there was no risk of malperfusion after concomitant graft deployment. An alternative strategy could be argued to expand the TL, but given the dissection up into the brachiocephalic vessels, there would be unclear consequences regarding cerebral perfusion, along with sacrifice of the celiac artery, which may also lead to complications avoidable with parallel TEVAR.

We believe that follow-up after this procedure should be conducted as would be for any chronic dissection patient treated with an endovascular approach for aneurysmal degeneration. In our practice, we typically perform a 1-month, 6-month, and yearly CT angiograph after repair.

CONCLUSIONS

In dissection involving the aortic arch, parallel TL/FL TEVAR may provide an effective alternative in select patients. Although open reconstruction remains the mainstay of therapy, we propose a minimally invasive solution for patients with contraindications to open repair.

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