Direct aortic access for endovascular thoracoabdominal aneurysm repair using a bifurcated endograft as a branched device

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ABSTRACT

Aortic aneurysms (AA) are a common complication in patients with large-vessel vasculitis, such as chronic phase Takayasu arteritis, that often require surgical management to prevent a lethal rupture. Historically, mainstay of treatment for AA in the setting of arteritis was traditional open repair. However, in this case study an alternative surgical approach was devised to successfully treat an extent III thoracoabdominal AA in a patient with a diagnosis of Takayasu arteritis and a complex surgical history that made her high risk for an open surgical intervention. This case study summarizes a hybrid surgical approach that successfully excluded a thoracoabdominal AA and revascularized the superior mesenteric artery and left renal artery, by directly accessing the infrarenal aorta and using a bifurcated abdominal aortic endograft as a two-vessel branched device. (J Vasc Surg Cases Innov Tech 2023;9:1-6.)

Keywords: Aneurysm; Takayasu arteritis; Vascular surgery; Endovascular; EVAR; Case report; Direct sac access; Endograft

Takayasu arteritis (TA) is a chronic, granulomatous vasculitis with unknown etiology that frequently affects large vessels, especially the aorta and its major branches (ie, coronary, carotid, pulmonary, and renal arteries).[1] The clinical course of TA has been said to progress in three distinct phases. Phases I and II exhibit nonspecific constitutional symptoms that progress to include vascular involvement (ie, vessel tenderness or pain). Progressive wall fibrosis or arterial lumen stenosis/occlusion eventually push TA into phase III (also known as burnt-out/chronic phase), where characteristic features of TA (pulselessness) manifest. This process, ultimately, leads to destruction of arterial media, inducing aneurysm formation.[1,2] Although TA has been shown to be most prominent in women under the age of 40 and in Asian countries,[3,4] current research seems to suggest that occurrence rates of aortic aneurysm (AA) secondary to TA are actually not only lower in Asian countries, but also higher in non-Asian countries as well as male patient populations.[5-12]

Patients who develop AA from TA often require several aortic surgeries to treat their aneurysms at various levels. Historically, the gold standard surgical treatment for such aneurysms has been open bypass and/or open aortic repair. In addition, past data have also shown that the administration of perioperative steroids may help to improve surgical outcomes by decreasing the risk of aneurysm degeneration/rupture, and minimizing postoperative wound healing duration.[12-16] However, a recent shift in the paradigm for treatment of complex AA suggests that there is a decreased perioperative mortality and shorter length of stay in hospital intensive care units for patients who undergo endovascular repair compared with those who undergo open surgical repair.[17-20] Unfortunately, endovascular repairs of complex AAs have been limited by device availability and, often times, inadequate iliac access size to insert devices into the aorta. In this case study, a patient with a type III thoracoabdominal aneurysm (TAAA) was treated with a hybrid surgical approach to successfully exclude the TAAA and revascularize the superior mesenteric artery (SMA) and left renal artery (LRA), by directly accessing the infrarenal aorta and using a bifurcated abdominal aortic endograft as a two-vessel branched device.

CASE REPORT

A 57-year-old woman with a biopsy-confirmed history of TA, currently in the chronic stage of disease and on no active anti-inflammatory medications (steroids, nonsteroidal immunosuppressants, nonsteroidal anti-inflammatory drugs, etc), presented to our institution for management of a 6.0 cm extent III TAAA. She had an extensive surgical history spanning 13 years, which included an open ascending thoracic AA (TAA) repair with hemiarch replacement, open descending TAA repair with an interposition Dacron tube graft, and bilateral iliac artery stenting that ultimately failed leading to an occluded aortoiliac system with subsequent left-sided axillobi-femoral bypass (AxBF). She has

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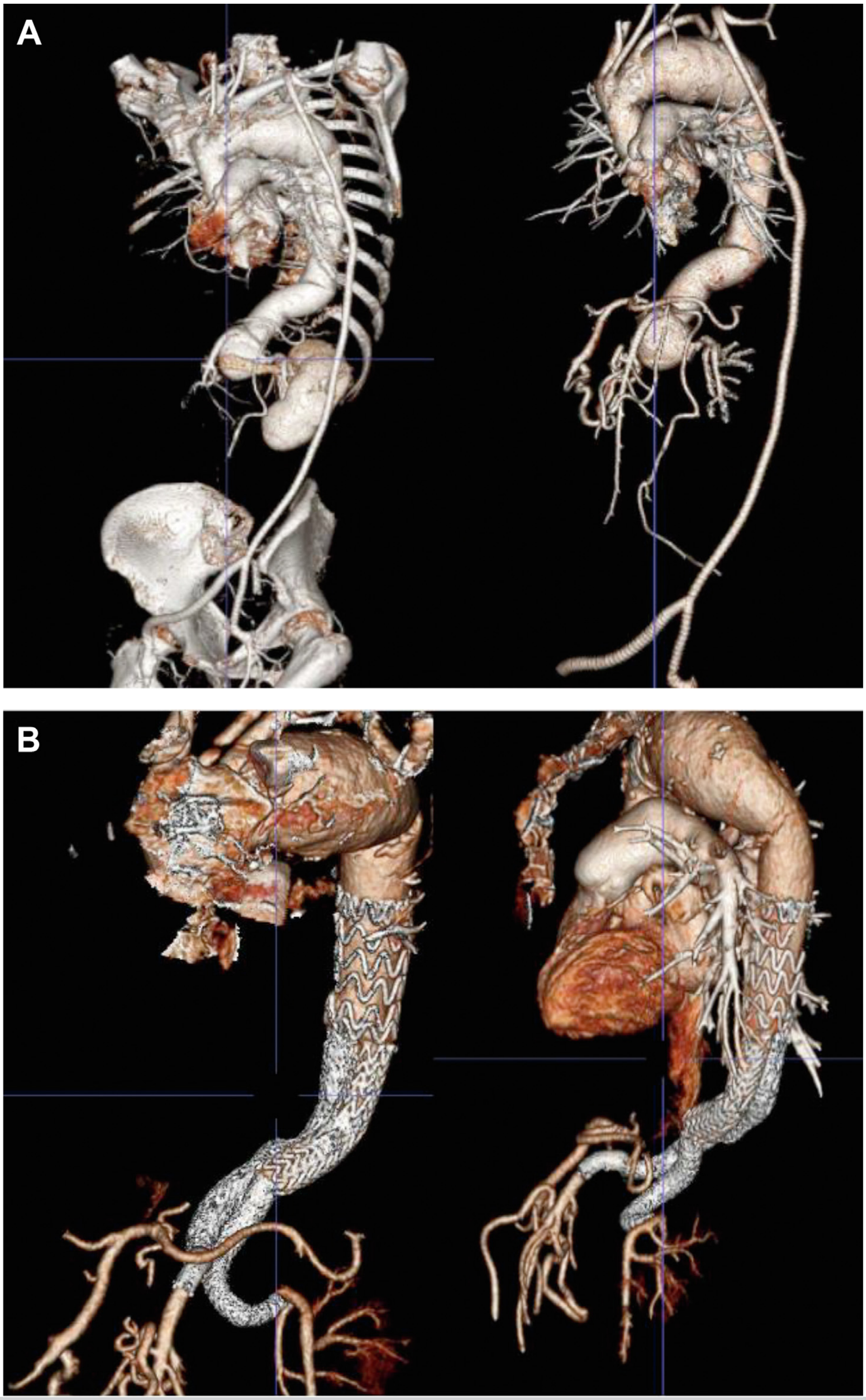

Fig 1. (A) Preoperative computed tomography (CT) angiogram shows minimal perfusion of the superior mesenteric artery (SMA) and left renal artery (LRA) and absent perfusion of the common iliac arteries owing to distal occlusion of the aneurysm sac. Lower extremity perfusion was provided solely by the patient's left-sided axillary-bifemoral bypass. **(B)** Postoperative CT angiogram shows successful implementation and repurposing of the 32-mm GORE abdominal endograft resulting in complete exclusion of the aneurysm sac.

Fig 2. (A) Through-and-through wire access with retrograde arterial access directly into the thrombosed aneurysm sac and insertion of the 20F DrySeal sheath. Anterograde arterial access through the right axillary artery and introduction of the 14F sheath. **(B)** Insertion of a 32-mm proximal diameter GORE Excluder abdominal endograft through the direct access transaortic sheath. Arrow indicates direct aneurysm sac access.

no family history of aortic or connective tissue disease. The patient has authorized release of case information and pertinent images for publication.

Computed tomography angiography imaging revealed a 6.0-cm extent III TAAA with an occluded celiac axis, occluded right renal artery, and occluded distal infrarenal AA (Fig 1, *A*). In addition, her left sided AxBF was patent and was providing perfusion to both of her lower extremities. Given her previous open TAA repair and left-sided AxBF bypass, a redo open thoracoabdominal repair with the AxBF in the way, would be quite complex and would carry a high risk for morbidity and mortality. Thus, we decided to treat this aneurysm with a hybrid endovascular approach via direct access of the aneurysmal sac. We chose a bifurcated abdominal endograft, with a proximal seal into the Dacron thoracic graft, and used the iliac limbs as branches for revascularization of the SMA and LRA, effectively excluding the aneurysm (Fig 1, *B*).

The patient had an uncomplicated postoperative course where she was administered clopidogrel (Plavix) and Warfarin with a Lovenox bridge and a goal international normalized ratio of 2 to 3. In addition, the patient was placed on perioperative aspirin and intensive statin therapy to prevent the development of cardiovascular events, per our institutional protocol for all patients undergoing endovascular TAAA. Of note, because the patient was diagnosed with TA many decades ago and exhibited an absence of fever, malaise, or any other systemic signs of active disease, adjunct perioperative medical management and maintenance biological therapy were deemed unnecessary and inflammatory serum markers were not monitored. She will be seen at the 1-, 6-, and 12-month follow-ups for CT imaging and monitoring for endoleaks.

OPERATIVE DETAILS

A small midline laparotomy and a standard transabdominal AA exposure was performed giving access to the thrombosed segment of the distal aneurysm sac. Direct sac access was obtained with a microneedle through a presecured pledgeted Prolene suture in a purse string fashion. Under fluoroscopy guidance, a wire was passed retrograde through the thrombosed aneurysm sac directly into the flow lumen of the TAAA, which was then dilated with a 7F sheath (Fig 2). After this access was secured, an intravascular ultrasound catheter was passed to confirm intraluminal access to the aorta. Next, an infraclavicular exposure of the right axillary artery was performed and anterograde arterial access to the thoracic aorta was obtained and the wire was snared from the transabdominal segment. After securing the through-and-through wire access, a 14F DrySeal was passed down the right axillary artery to the descending thoracic aorta for anterograde access to the branches of the TAAA. The patient was anticoagulated with systemic intravenous heparin. A 20 F DrySeal sheath was inserted via the direct aortic access over the through-and-through wire allowing both antegrade and retrograde sheath access. Next, a 31-mm proximal diameter GORE Excluder abdominal endograft (W. L. Gore & Associates, Flagstaff, AZ) was brought into the surgical field

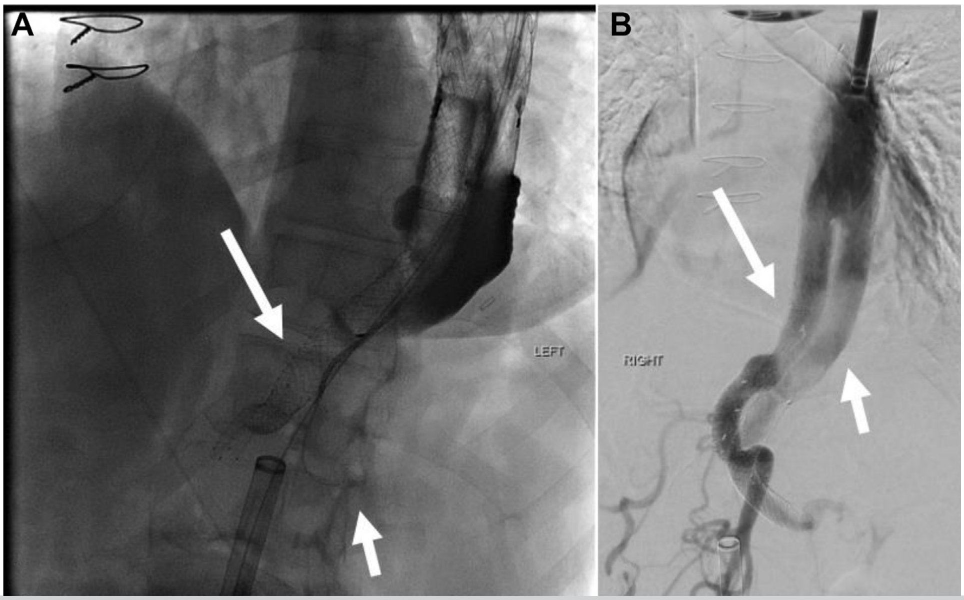

Fig 3. (A) Gore Excluder main body deployed within the Dacron graft with the limb of the graft stented into the superior mesenteric artery (SMA) and cannulation of the left renal artery (LRA). **(B)** Completion angiogram of two-vessel branch reconstruction without endoleak. Short arrows indicate the LRA; long arrows indicate the SMA.

and advanced through the transaortic sheath into the descending aortic Dacron graft. The endograft was then deployed with the proximal main body sealing in the Dacron portion of the previous descending aneurysm repair with the contralateral gate opening toward the SMA and the distal end of the ipsilateral limb landing 20 mm above the origin of the LRA.

From the antegrade axillary sheath, the contralateral gate was cannulated and the SMA was selected. An angiogram via the catheter to the SMA confirmed selection of the branch and it was exchanged for a Rosen wire. Next, the bridging between the contralateral gate of the Excluder endograft and SMA was completed. In sequence, a 8-mm × 5-cm Viabahn was deployed into the SMA followed by two 11-mm × 79-mm VBX stents to bridge into the contralateral gate and postdilated with a 12-mm balloon. This branch seemed to be unstable and required an iliac extender from the gate into the SMA branch using a 16-mm × 14.5-mm × 11.5-cm Gore iliac limb. After the SMA was reperfused, the LRA bridging was performed using the ipsilateral limb of the deployed GORE Excluder endograft. From the antegrade axillary sheath the ipsilateral gate was cannulated and the LRA was selected (Fig 3). An angiogram was performed after cannulation of the LRA and the catheter was exchanged to a Rosen wire for stability. Then a 7-mm × 5-cm Viabahn stent was deployed into the LRA, where it was bridged into the ipsilateral gate using another 7-mm × 59-mm VBX followed by an 11-mm × 79-mm VBX stent.

A completion angiogram showed complete exclusion of the aneurysm sac. The angiogram and lack of pulsation confirmed no pressure in the aneurysm sac, and the patient remained hemodynamically stable. The transaortic sheath was removed and the Prolene purse string suture achieved adequate hemostasis without need for further repair suture. The patient tolerated the surgery well, was extubated, and was transferred to the recovery room in stable condition.

DISCUSSION

In this report, we describe a case of direct aortic access for placement of an infrarenal bifurcated endovascular device, used as a two-vessel branch endograft for treatment of a complicated TAAA with no conventional options. During the planning phase, physician modified endograft with two vessel fenestrations, physician modified endograft with two branches, and transcable approach to the aneurysm were the primary alternative endovascular/hybrid options that were considered. However, further discussion deemed that the degree of technical difficulty for proficient execution of these approaches was too great in this particular patient. In the past, open repair of TAA has always been the gold standard for surgical intervention. However, modern technology has challenged this stance by providing the necessary tools to revolutionize minimally invasive surgical management of complex vascular pathologies such as TA.

In the early phases of endovascular aortic surgery, research had suggested that postoperative complication rates and outcomes of endovascular repair were similar to or worse than those of open surgical repair in patients with TA.[21,22] Despite recent technical advancements, there remains controversy as to whether one technique should be considered over the other. Studies have shown that while both approaches are safe and efficient, open repair seems to offer greater vessel patency and revascularization.[23,24] However, this seems to be primarily described in the context of acute symptomatic TA. Glucocorticoids and immunosuppressive drugs seem to remain as the cornerstone for retaining vessel patency in patients with TA; however, their effect seems to only be described in acute or refractory TA owing to the presence of active endothelial dysfunction.[25-27] The literature regarding factors that effect branch vessel patency in asymptomatic chronic or burnout phase TA remains sparse. Interestingly enough, there does seem to be evidence that patients with TA tend to benefit more immediately from endovascular procedures than open procedures.[28] Kim et al[29] report that patients who underwent endovascular treatment for TA were less likely to suffer from early postoperative complications. In addition, Lee et al[30] supported endovascular management of TA as a durable treatment modality owing to notable clinical improvement in patient presentations over 4 years of follow-up.[30] Unfortunately, more longitudinal data and evidence are needed for a definitive verdict.

Despite minimally invasive techniques, such as endovascular aneurysm repair (EVAR) and thoracic EVAR (TEVAR), having become fundamental procedures in the field of vascular surgery, decisions regarding preferred access sites and approach still vary among clinicians on a case-by-case basis. Yet, one point of commonality in the literature is that direct aortic endovascular access is primarily described in the context of being an alternative to standard transfemoral access when the latter is unsuitable.[31,32] Although this approach is currently still being explored, it has been reported in a handful of successful case reports. Botta et al[33] and Wada et al[34] have both reported the use of TEVAR via direct aortic access in patients with inadequate peripheral access and severe aortic calcification. Fanelli et al[35] have also used direct percutaneous aneurysmal sac access to embolize type II endoleaks in patients with AAA. Bruschi et al[36] have even reported the use of direct aortic access for transcatheter aortic valve implantation. Direct aortic access shows promising potential as a modality for EVAR/TEVAR approach in cases with difficult access or technically challenging alternatives.

In our case, this technique allowed the unique deployment of a bifurcated abdominal endograft (GORE Excluder) to be repurposed successfully to provide bridging branches for revascularization of the LRA and SMA and exclusion of a TAAA. In addition, balloon-expandable covered stents provided a functional and sufficient seal to bridge the endograft limbs to the intended vascular branches. Based on our results, we recommend that the deployment of the graft be contingent upon the positioning of the ipsilateral gate of the branched endograft. In this case, specifically, the ipsilateral gate was positioned 20 mm above the LRA and achieved appreciable results. Unfortunately, we experienced slight difficulty in establishing one of the bridges owing to unforeseen SMA instability during our procedure. However, this was mainly attributed to the distance the bridging stent needed to travel within the aneurysm sac (several centimeters) to connect the contralateral limb of the endograft to the SMA. Thus, the deployment of a GORE iliac extension limb was able to resolve this issue quite easily. Despite this minor complication, the outcome of our procedure was excellent. We believe that endovascular repair can potentially be an innovative yet effective means of surgical management of TAAA for high risk patients with complex surgical histories, including those with complicated vascular comorbidities and unfavorable access.

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