Endovascular rescue of failed physician-modified multibranched endografts with fabric tear, using Gore thoracoabdominal multibranched endoprosthesis

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ABSTRACT

The thoracoabdominal multibranch endoprosthesis is a commercially available off-the-shelf four-vessel inner branched endograft for complex abdominal and thoracoabdominal aortic aneurysms. Type IIIb endoleak owing to fabric tear of fenestrated branched endovascular repair (FBEVAR) can be challenging, often requiring relining FBEVAR. Here, we present a case where thoracoabdominal multibranch endoprosthesis was used to reline the previous physician modified FBEVAR in a patient with a 10-cm extent IV thoracoabdominal aortic aneurysm distal to the previous open extent I thoracoabdominal aortic aneurysm repair. (J Vasc Surg Cases Innov Tech 2024;10:101603.)

Keywords: Thoracoabdominal aortic aneurysm; Thoracoabdominal multibranch endoprosthesis; Fenestrated branched endovascular repair

Owing to its lower morbidity and mortality rates, fenestrated and branched endovascular aortic repair (FBEVAR) has become the primary treatment modality for complex abdominal aortic aneurysms (CAAAs) and thoracoabdominal aortic aneurysm (TAAA) at increasing number of high-volume aortic centers.[1-3] Most of the literature on FBEVAR has been with company-manufactured devices (CMDs). Although commercially available CMDs are the preferred device, access to these devices for TAAA has been limited, which has prompted an increasing number of centers to perform FBEVAR with physician-modified endografts (PMEGs) in both the elective and urgent settings. Recently, Thoracoabdominal Multibranched Endoprosthesis (TAMBE, W. L. Gore & Associates, Flagstaff, AZ) obtained commercial approval from the US Food and Drug Administration, as the first dedicated, off-the-shelf, four-vessel branched endograft for the treatment of CAAA and TAAA in the United States. In this report, we describe a novel application of the TAMBE device, used to repair failed PMEG with a fabric tear in a patient with chronic dissection TAAA and prior open TAAA repair. The patient provided consent for publication. Institutional review board approval was waived based on the retrospective nature of this report.

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CASE REPORT

A 40-year-old man with Marfan's syndrome, hypertension, type A aortic dissection, and complex previous aortic reconstructions including Bentall and arch replacement, followed by descending thoracic aortic replacement with reimplantation of T11 intercostal artery through a thoracoabdominal exposure 5 years prior, presented with acute-onset flank and abdominal pain.

Computed tomographic (CT) imaging demonstrated an extent IV TAAA with a dissection flap in the infrarenal aorta and maximal diameter of 10.7 cm in the infrarenal aorta, as well as a concomitant left common iliac artery aneurysm measuring 5.3 cm (Fig 1, *A* and *B*). In addition to the aortic findings, patient had left hydronephrosis with rupture of the left ureter with retroperitoneal urine extravasation (Fig 1, *C*). The patient underwent left ureteral stent placement. Given the large aneurysm size, urgent aortic repair options including redo open repair and FBEVAR including referral to a center with CMD access, PMEG, and compassionate use of then investigational TAMBE were discussed. Given the urgency of repair based on the aneurysm size and patient preference for endovascular repair, PMEG was planned.

PMEG incorporating four directional branch cuffs for visceral and renal arteries, and 1 fenestration for an enlarged T10 intercostal artery was designed using a double tapered Zenith TX2 thoracic stent graft (Cook Medical, Bloomington, IN) (Fig 2, *A*). The PMEG main body was deployed aligning the fenestration to the intercostal artery (Fig 2, *B*). The intercostal artery was stented with a balloon-expandible iCAST stent, and the remaining target vessels were stented with self-expanding Viabahns without oversizing and avoiding balloon angioplasty of the target vessel. A Gore Excluder bifurcated stent was deployed, then a left iliac branch endoprosthesis (W. L. Gore & Associates) with the internal iliac component bridged with Viabahn introduced from the up-and-over contralateral femoral approach (Fig 2, *C*). This completed the repair with five-vessel fenestrated, branched PMEG with left iliac branch endoprosthesis (Fig 2, *D*).

The patient tolerated this procedure well and his postoperative course was uneventful. After initial postoperative scan at 4 months showed sac regression to 9.9 cm (Fig 2, *E*), he

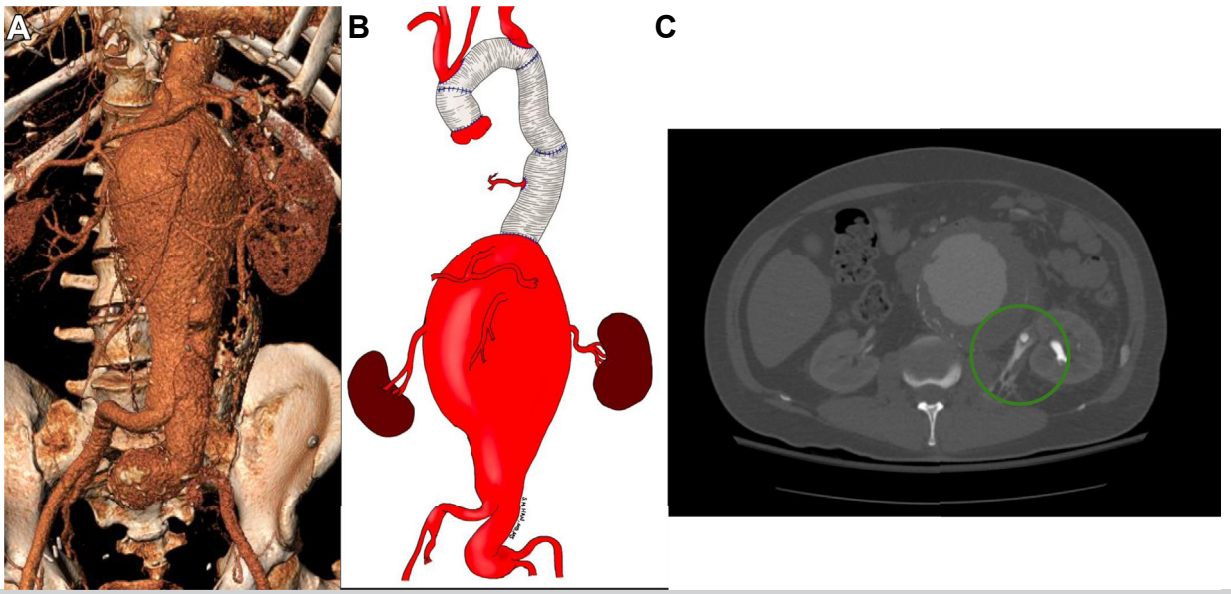

Fig 1. (A) Three-dimensional reconstruction computed tomographic (CT) image showing extent IV thoracoabdominal aneurysm and left common iliac artery aneurysm. **(B)** Schematic of the patient's preoperative anatomy and previous open aortic graft replacements with patent intercostal artery present. **(C)** Left ureteral rupture seen with associated urine extravasation (circled).

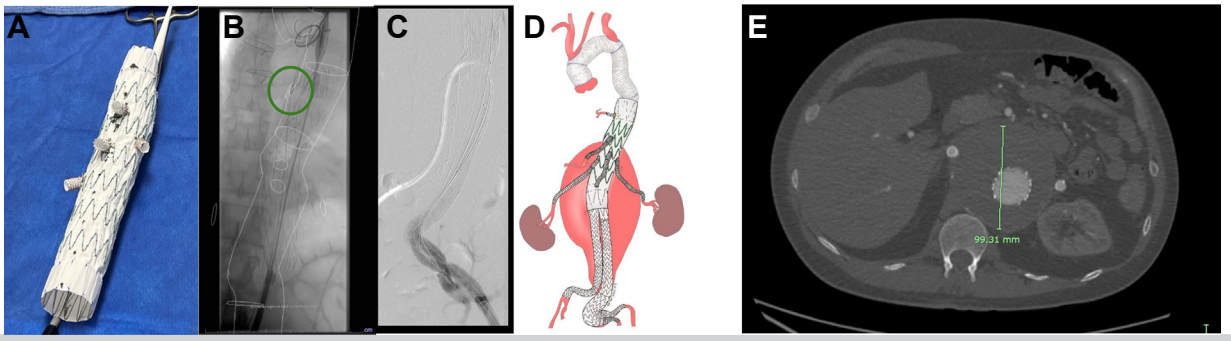

Fig 2. (A) Physician-modified endograft (PMEG) with four visceral directional branch cuffs. The Intercostal fenestration is located on the posterior portion of the graft. **(B)** Alignment of intercostal fenestration with three-dimensional overlay imaging (circled) for optimal positioning of PMEG main body graft. **(C)** Completion angiogram of left iliac branch endoprosthesis device with Viabahn extension of internal iliac artery showing adequate flow with no endoleaks. **(D)** Schematic showing completion anatomy after four vessel fenestrated branched endovascular repair (FBEVAR). **(E)** Postoperative scan at 4 months showing sac regression to 9.9 cm from 10.7 cm.

re-presented 1 month later with sudden onset of severe back pain and was, again, transferred to our center. CT imaging at this time was concerning for endoleak in the vicinity of the left renal component, with sac expansion (Fig 3, *A*). Diagnostic angiography confirmed a type IIIb endoleak likely owing to a fabric tear of the PMEG main body near the vicinity of branch cuffs. Consequently, operative repair options were discussed, which included open conversion with PMEG explant through a redo thoracoabdominal incision, as well as the off-label use of a recently commercially approved TAMBE in the setting of previous FBEVAR. The patient elected for redo FBEVAR using TAMBE to repair this endoleak. Description of TAMBE components and implantation steps have been published.[4]

Under general anesthesia, percutaneous right femoral access and open exposure of the left brachial artery were performed. Using the Tri-Lumen catheter, five through-and-through brachial to femoral wires were established. Using a buddy catheter via the left brachial approach, the intercostal fenestrated branch was accessed and snorkel branch was deployed using a 5 mm × 79 mm VBX covered stent (Fig 3, *B*). A 37-mm TAMBE main body was then preloaded and partially deployed alongside the intercostal snorkel stent. Using the preloaded wires,

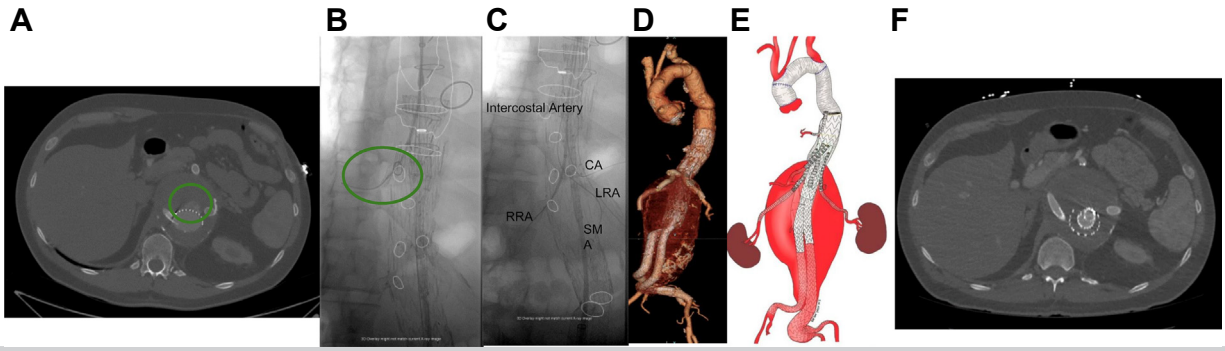

Fig 3. (A) Type IIIb endoleak seen coming off the main body graft near the left renal artery stent (circled). **(B)** Intercostal artery was snorkel stented before deployment of thoracoabdominal multibranch endoprosthesis (TAMBE) main body graft (circled). **(C)** Labeled catheterization of all visceral and renal vessels before stent deployment. **(D)** Completion three-dimensional reconstruction of TAMBE within fenestrated branched endovascular repair (FBEVAR) with no endoleaks seen. **(E)** Schematic showing TAMBE inside previous FBEVAR. **(F)** Postoperative scan showing resolution of the type IIIb endoleak. CA, Celiac artery; *LRA*, left renal artery; *RRA*, right renal artery; *SMA*, superior mesenteric artery.

the celiac artery, superior mesenteric artery, and bilateral renal arteries were catheterized (Fig 3, *C*). The proximal half of the TAMBE device was deployed, followed by bridging stent deployment using the appropriately sized VBX covered stents. The eye-of-the-tiger molded parallel grafting technique was used for the intercostal stent. The distal bifurcated component was then placed, and extended into the previous iliac limbs, achieving complete relining of the FBEVAR (Fig 3, *D* and *E*). The case required 49 minutes of fluoroscopy time and 100 mL of iodinated contrast. Estimated blood loss was <100 mL. The patient recovered uneventfully and was discharged home on postoperative day 4. At the 1-month follow-up, the patient remained asymptomatic and CT imaging demonstrated excellent stent graft apposition with patent target vessels and resolution of type IIIb endoleak (Fig 3, *F*).

DISCUSSION

FBEVAR has demonstrated technical feasibility, safety, and lower perioperative morbidity as a treatment modality for TAAA and previous failed EVAR.[5] Prior reports have demonstrated that off-the-shelf devices can be used effectively and safely beyond their instructions for use.[6,7] In this report, we demonstrate the technical feasibility of TAMBE in a patient with three complicating factors: a history of connective tissue disorder (Marfan syndrome), prior open thoracoabdominal aortic repair, and failed PMEG owing to device integrity issues.

Open surgical repair remains the gold standard for patients with a connective tissue disorder. However, when patients present with previous open aortic reconstruction or physiological decompensation, open repair becomes increasingly difficult. In these circumstances, FBEVAR has been performed with promising early results.[8-11]

There are several reports regarding multibranched stent grafts after prior aortic surgery. In a two-center study by Eleshra et al,[12] the authors examined short-term outcomes of the multibranched t-Branch (Cook Medical) for reintervention after prior infrarenal aortic repair in 32 patients (75% open surgical repair and 25% EVAR). They report technical success of 97%, target vessel patency of 97.5% at 12 months, and cumulative freedom from reintervention of 90% at 12 months.[12] Furthermore, Han et al[13] had previously reported the feasibility of TAMBE for failed infrarenal EVARs with type IA endoleak. The current report takes that concept a step further by successfully implanting TAMBE in the setting of prior five vessel FBEVAR. We found that the TAMBE design can offer a distinct advantage in challenging anatomy, including a previous FBEVAR, because the preloaded wires facilitated access through the respective inner branches while providing sheath stability during the target vessel catheterization, which in our case was a previous branch cuff. Finally, the long-term durability of this repair is unknown and the patient's history of Marfan syndrome warrants close surveillance.

CONCLUSIONS

We demonstrate technical success, safety and favorable short-term outcomes with off-label use of the TAMBE in a patient with prior FBEVAR. With recent commercial approval, TAMBE may provide a solution of a variety of complex challenges. Postmarket registry data, which include the outcomes of on and off-label TAMBE will be paramount in guiding the future application.

DISCLOSURES

S.M.H. is a consultant for Cook Medical, W. L. Gore & Associates, and Terumo Aortic and is a member of the scientific advisory board for W. L. Gore & Associates, Terumo Aortic, and Vestek.

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