Branched endograft repair of an aortic stump aneurysm

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We present a patient with an aortic stump aneurysm that was repaired with a custom-made, four-branched thoracoabdominal endograft. The repair was performed in two stages using a special delivery system designed to be introduced in an antegrade manner through a median sternotomy due to a lack of iliofemoral access. At 1 year, the patient remains in good health, with his aneurysm completely excluded and decreased in size, without migration, and all branch vessels patent. This report represents a unique endovascular repair of a complex aortic pathology in a patient without other surgical options. (J Vasc Surg Cases 2015;1:177-9.)

Despite advances in technology, repair of complex aortic aneurysms still poses unique technical challenges.[1] Even after successful repair, late complications have been observed in up to 9.4% of patients.[2] Surgical management of these complications is often more technically difficult than the repair of the original aortic pathology, sometimes requiring unique and creative solutions. We present a patient with an aortic stump aneurysm that was repaired with a custom-made, branched thoracoabdominal endograft. Consent for publication was obtained from the patient.

CASE REPORT

The patient is a 77-year-old African American man with a medical history of hypertension, myocardial infarction, and abdominal aortic aneurysm (AAA). In 2003, he underwent open surgical repair of the AAA, complicated by a late aortoenteric fistula and treated with graft excision, oversewing of the aortic stump, and bilateral axillofemoral bypasses. Three years later, right leg ischemia required an above-the-knee amputation (AKA). In 2007, he presented with an open right groin wound with graft exposure and active bleeding. His right axillofemoral bypass was noted to be disrupted and was subsequently excised.

In 2008, he acquired a multidrug-resistant *Pseudomonas* infection of the left axillofemoral bypass presenting with axillary and femoral mycotic pseudoaneurysms subsequently treated with left axillofemoral graft excision and a left AKA. Two years after the left AKA, he underwent an aorta-to-left renal artery bypass using a rifampin-coated bifurcated graft for presumed renal ischemia (details of the procedure and exact indications were not available). Follow-up computed tomography angiography in 2012 showed a 5.3-cm aortic stump aneurysm, which increased to 7.0 cm by 2013 (Fig 1).

Despite his multiple surgeries and bilateral amputations, at 75 years old he remained completely functional: he resided at home, performed all activities of daily living independently, and even drove a specially designed handicap van. However, due to the location of the aneurysm and his multiple prior open repairs, he was no longer thought to be an open surgical candidate.

After fulfilling the United States (U.S.) Food and Drug Administration requirements for compassionate use of unapproved medical devices,[3] the patient underwent a staged endovascular repair using a custom-made, four-branched endograft (Cook Medical, Bloomington, Ind). Standard retrograde transfemoral access was impossible due to bilateral occlusion of iliofemoral arteries, and antegrade delivery was planned. Therefore, the endograft was reverse-loaded onto the delivery system with its distal end at the tip and the proximal end toward the handle (Fig 2, *A*). The nosecone was further modified with a short blunt tip to accommodate the blind end of the aortic stump. The company preloaded the endograft onto the delivery system, and no back-table manipulation was performed.

In the first stage, through an upper median hemisternotomy and a 10-mm Dacron (DuPont, Wilmington, Del) conduit sewn to the ascending aorta, the 24F delivery catheter was advanced to the distal thoracoabdominal aorta. Angiographic access was obtained through a separate puncture of the aortic conduit. After the endograft was successfully deployed, the conduit was oversewn, and the sternotomy was closed over chest tubes.

After recovering overnight, the patient was returned to the operating room for second-stage completion. The proximal left brachial artery was exposed and used to access each of the four down-going branches (celiac, superior mesenteric, and left and right renal) of the endograft and deliver a combination of covered (Viabahn; W. L. Gore, Flagstaff, Ariz; Fluency, Bard, Tempe, Ariz) and uncovered (Zilver; Cook Medical, Bloomington, Ind) bridging stents to the native vessels. Branch access was facilitated by the tapered design of the custom-made branch endograft allowing adequate space for manipulation of the catheters into their respective target arteries. The distal end of the endograft was occluded using 16-mm and 18-mm Amplatzer plugs (St. Jude

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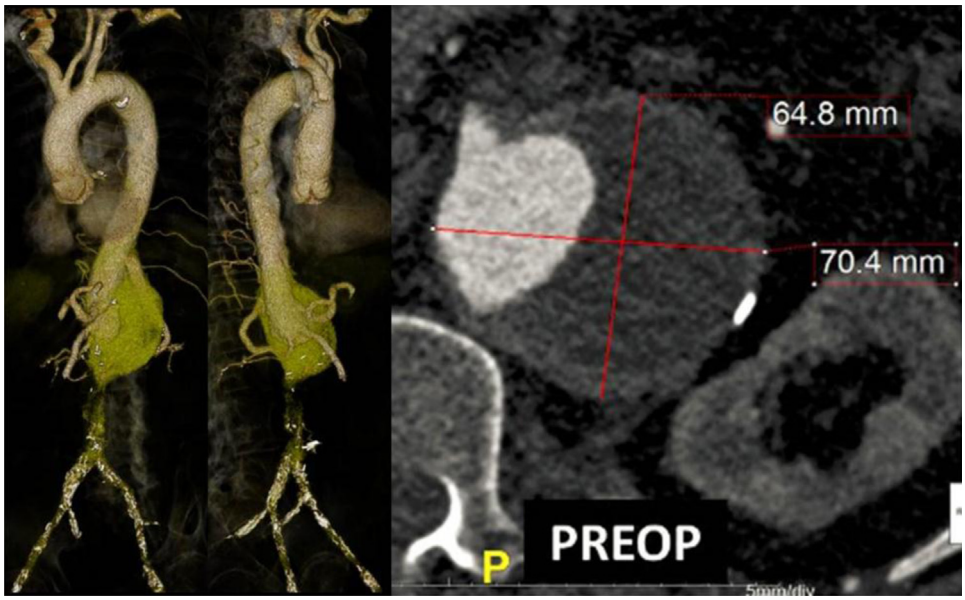

Fig 1. Left, Three-dimensional volume-rendered image shows the preoperative aneurysm and the bypass graft. **Right,** Computed tomography angiogram shows the aneurysm size.

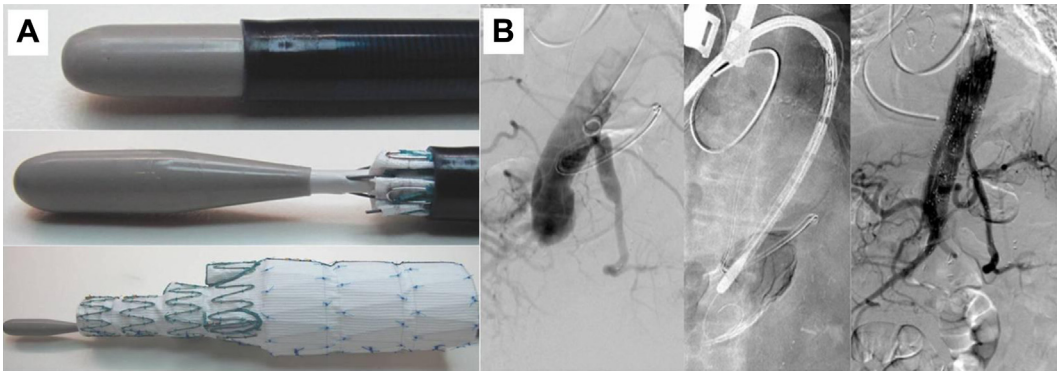

Fig 2. A, Endograft and custom delivery system. **B, Left,** Initial aortogram, **(middle)** reverse-loaded endograft being delivered antegrade, and **(right)** completion angiogram.

Medical, St. Paul, Minn) deployed in a stacked manner. The completion angiogram showed wide patency of all branches and no type I or III endoleaks (Fig 2, *B*).

The patient tolerated the procedure well and recovered in the cardiovascular intensive care unit. He was transferred to the general care floor on postoperative day 3 and discharged on postoperative day 6. Preoperative and postoperative renal function remained unchanged (preoperative and postoperative: creatinine, 1.1 mg/dL; estimated glomerular filtration rate, >60 mL/min).

Computed tomography angiography at 1 month showed patency of all four branches and complete exclusion of the aneurysm without evidence of endoleak and an aneurysm size of 70.2 × 69.8 mm. Repeat imaging at 1 year showed a stable endograft without migration, all branches were patent, no endoleak, decreased aneurysm size to 67.6 × 61.7 mm, and a creatinine of 1.4 mg/mL and estimated glomerular filtration rate of 57 mL/min (Fig 3).

DISCUSSION

Most patients who undergo standard surgical repair of an AAA remain free of any significant graft-related complications. However, late events, such as anastomotic pseudoaneurysms (3.0%), graft-enteric fistulas (1.6%), and graft infections (1.3%), can occur with an overall incidence of 7%.[2] In the current case, an aortoenteric fistula developed after the patient's index AAA repair. Aortoenteric fistulas mandate graft excision and management of the residual proximal aorta. Two methods typically used include an extra-anatomic bypass with oversewing of the aortic stump, as was done in this patient, or in situ revascularization using a prosthetic (typically expanded

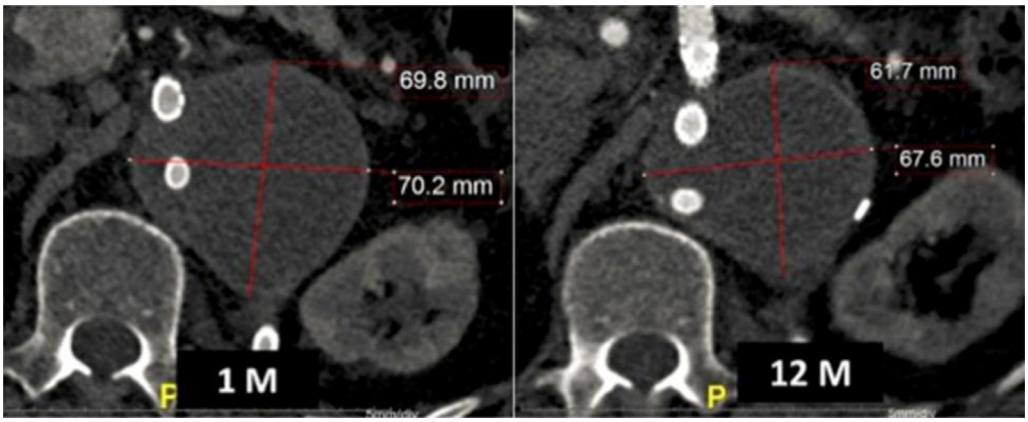

Fig 3. Computed tomography angiograms at **(left)** 1 month and **(right)** 12 months show decreased aneurysm size and no endoleak.

polytetrafluoroethylene or allograft) or autogenous neoaortoiliac system conduit. In general, however, aortic graft infections can be associated with high mortality and amputation rates and acute disruptions or late (pseudo)aneurysms of the aortic stump or proximal suture line.[4]

All large or symptomatic pseudoaneurysms should undergo elective repair. Open repair can be enormously challenging due to scarring of the periaortic tissue and management of the mesenteric and renal arteries, rendering these patients inoperable using conventional techniques. However, endovascular techniques may obviate some of these challenges. Limited global experience has been previously reported using branched endografts for repair of thoracoabdominal aortic aneurysms.[5,6] Only recently, the Zenith t-Branch, a standard four-vessel branch device (Cook Medical) has become commercially available outside of the U.S., but in the U.S. experience, has been limited to a few investigators under an U.S. Food and Drug Administration-approved physician-sponsored investigational device exemption. Most of this experience has involved custom-made devices using different combinations of branch sizes, locations, orientations, and mix of branches and fenestrations.

Specific issues unique to the current case involving the design of the endograft, delivery system, and conduct of the procedure included lack of iliofemoral vessels, unusual origin of the left renal artery bypass, and the aortic stump. The repair was staged due to the need for antegrade deployment of the endograft. The patient needed to be fully anticoagulated during the branch portion of the procedure, which typically takes 2 to 3 hours. This would have resulted in a significant amount of insensible blood loss from the open sternotomy. The decision was made to allow hemostasis to occur overnight after reversal of the anticoagulation and perform the branch portion of the repair at a separate setting. Unlike fenestrated endografts, branched endografts do not rely on precise registration of the branches to their target vessels. Therefore, deployment of the endograft can be largely decoupled from the branch portion of the repair.

At 1 year, the patient remains in good health, without any interval device-related events. One particular concern is whether the aortic stump aneurysm may have been mycotic in origin. Because the patient's problem started with an aortoenteric fistula, a myocytic pseudoaneurysm cannot be ruled out. Results of multiple blood cultures were negative, and there was no radiographic evidence of an active infection. The patient was managed initially with a brief course of intravenous antibiotics and transitioned to a short term of oral antibiotics, which was discontinued after consultation with infectious diseases. To date, the patient remains free of any systemic or radiographic signs of bacteremia or periaortic inflammatory process.

CONCLUSIONS

This case represents a unique use of a branched endograft technology to repair a complex aortic pathology in a patient without other surgical options. As in all new technologies and techniques, success can only be determined with late follow-up, and cautious optimism is warranted.

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