

Extra-anatomic bypass with open-plugging stent graft for extensive dissected aortic aneurysm

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Treatment for an extensively dissected aortic aneurysm is a surgical challenge. Open surgery using a left thoracotomy is promising but can be dangerous in patients with pulmonary comorbidity. We treated a 63-year-old man with chronic type B aortic dissection with aneurysmal change and ascending aortic dilation. The thoracoabdominal aorta was also dissected, dilated, and tapered; thus, a simple hybrid strategy was not possible, even with open fenestration. We performed ascending aortic replacement with reconstruction of the cervical vessels and extra-anatomic bypass from the ascending to descending aorta, with aneurysmal isolation. A stent graft was inserted at the true lumen of the residual aneurysm to reduce endopressure. Total thrombosis and reduction in size of the aneurysm was achieved, and the patient recovered well, without complications. (*J Vasc Surg Cases* 2015;1:32-5.)

Surgical repair of extensive dissected aortic aneurysm is challenging. Patients are often complicated by postoperative pulmonary complications. Avoiding graft replacement through a left thoracotomy is preferable in patients with pulmonary comorbidity. Extra-anatomic bypass with aneurysm isolation, first described by Carpentier et al,¹ can be performed through a median sternotomy, with or without an upper laparotomy. However, this technique is rarely used currently because backflow from intercostal arteries and mediastinal branches is uncontrollable and the long-term result is unwarranted.

We here present a case of a patient with obstructive pulmonary disease and an extensively dissected aortic aneurysm who was successfully treated by extra-anatomic bypass. The aneurysm was isolated, and a stent graft was inserted into the true lumen of the aneurysm to reduce type II endoleak from intercostal arteries. Patient consent to the publication was obtained.

CASE REPORT

A 63-year-old man was emergently admitted to our hospital with sudden onset of chest pain. His medical history included type B aortic dissection 12 years before the admission, emphysema

from cigarette smoking, mild renal dysfunction, and alcoholic liver dysfunction. He was obese (body mass index, 31.9 kg/m²). Shock was not present.

A contrast-enhanced computed tomography (CT) scan on admission revealed a dissected aortic aneurysm from the aortic arch to the bilateral common iliac arteries. The maximum diameter of the descending aorta was 68 mm, and the aorta around the origin of the celiac artery was tapered (diameter range, 38-46 mm; *Fig 1, A*). The ascending aorta was also dilated (maximum diameter, 51 mm). There was mediastinal hematoma with no extravasation, indicating contained rupture.

Because the patient had no symptoms after administration of antihypertensive therapy, no progressive anemia, and had stable circulatory condition, we opted for intentionally delayed surgery. A simple extensive graft replacement via left thoracotomy was contraindicated due to the risk of postoperative pulmonary morbidity. A two-stage hybrid procedure, including the open fenestration technique was not possible, because no distal landing zone was available. Considering the patient's condition, we decided to perform (1) ascending aortic replacement with neck vessel reconstruction and (2) extra-anatomic bypass from the ascending to the descending aorta with aneurysmal isolation.

The CT showed the superior intercostal artery (origin of right-side Th1 and Th2) was thin and arose from the true lumen in a horizontal segment of the descending aorta. Left-side Th1, Th2, and Th3 intercostal arteries were not evident, nor were the bronchial branch and esophageal branch. Left-side thin Th4 and Th5 intercostal arteries only arose from the false lumen, whereas the right-side branches arose from the true lumen. Th6 to Th11 intercostals were thick and all from the true lumen (*Fig 1, B and C*). To reduce the endopressure inside the residual aneurysm, a stent graft was inserted at the true lumen of the dissected aneurysm to cover the major intercostal arteries (Th6 to Th11).

All procedures were performed through a median sternotomy and upper laparotomy. The diaphragm was incised vertically, and the descending aorta proximal to the origin of celiac artery was encircled. A 260-cm hydrophilic guidewire was inserted toward the ascending aorta from the left femoral artery. Cardiopulmonary bypass (CPB) was established through aortic cannulation and

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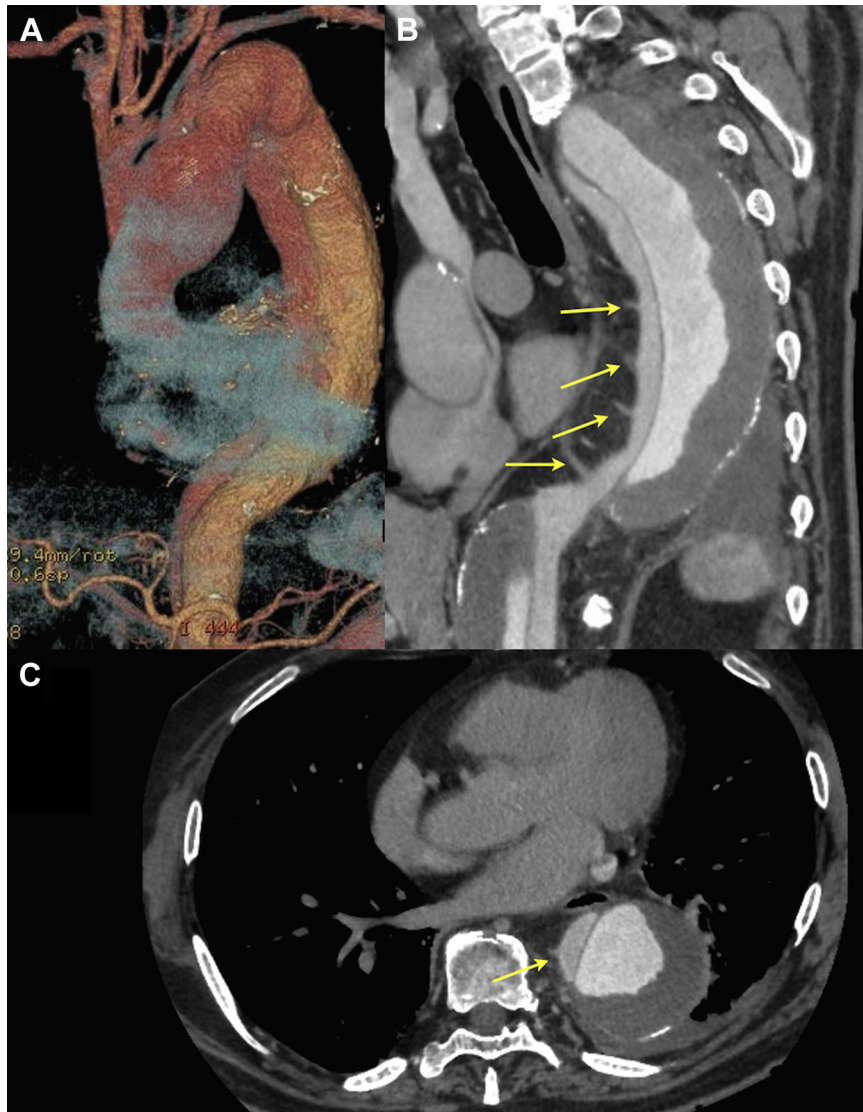


Fig 1. A, Preoperative computed tomography (CT) scan reveals a dissected aortic aneurysm from the transverse aortic arch to the thoracoabdominal aorta with ascending aortic dilation. B, Thick intercostal arteries (*arrows*) at the level of Th6 to Th11 arose from the true lumen of the dissected aneurysm. C, Axial view shows the true lumen of the aorta was positioned in the medial side. The *arrow* shows an intercostal artery (Th9) arising from the true lumen.

bicaval drainage. A 10-mm prosthetic graft was anastomosed to the right femoral artery and was used for additional arterial perfusion.

After systemic cooling to 28°C, circulatory arrest was obtained, and the aortic arch was incised. Selective cerebral perfusion was established. A 28-mm × 10-cm Gore TAG stent graft (W. L. Gore & Assoc, Flagstaff, Ariz) was inserted via the guidewire. The landing zone was identified by transesophageal echocardiography. The proximal stump of the aneurysm was made using a circumferential felt strip and a single felt strip inserted to the true lumen. Horizontal mattress suture, followed by over-and-over suture, was placed. After the stump was made, distal perfusion was temporarily restarted.

A 24-mm × 12-mm Y-shaped Dacron (DuPont, Wilmington, Del) Hemashield Platinum graft (MAQUET Cardiovascular, LLC, Wayne, NJ) with two hand-made side branches (10 mm × 1, 26 mm × 1, Hemashield Platinum) was anastomosed proximally. The aorta was declamped, and proximal coronary perfusion was restarted from a 10-mm side branch. Thereafter, each neck vessel was individually reconstructed. After the proximal aortic reconstruction, circulatory arrest was reobtained. The thoracoabdominal aorta at the level of the diaphragm was incised, and a distal stump of the aneurysm was made in the same fashion as that for the proximal stump. A fenestration of ~3 cm was made, followed by distal anastomosis with a 30-mm straight tube graft. Finally, proximal and distal tube grafts were anastomosed intrapericardially

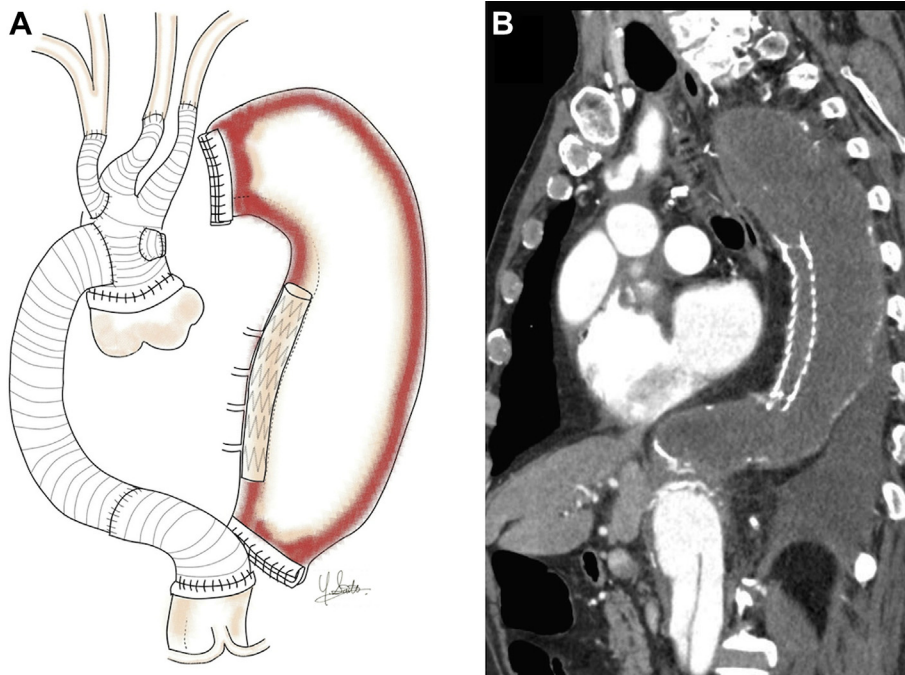


Fig 2. **A,** Schema shows the extra-anatomic bypass with a plugging stent graft. **B,** A postoperative computed tomography (CT) scan reveals complete thrombosis and regression in the size of the aneurysm.

(Fig 2, A). Weaning from CPB was not difficult. Total CPB, aortic cross-clamp, and total circulatory arrest times were 363 minutes, 94 minutes, and 93 minutes, respectively.

The patient had no cerebral infarction, paraplegia, visceral disorders, or pulmonary morbidity. Postoperative early-phase and delayed-phase CT demonstrated complete thrombosis of the residual aneurysm and shrinkage of the aneurysm with a maximum diameter of 56 mm (Fig 2, B). The patient remains well at 1 year after surgery.

DISCUSSION

Surgery for extensive dissected aortic aneurysm is challenging. One-stage open repair is conventional but serves as a definitive procedure for this complicated subset of patients. Kouchoukos et al² described 68 recent cases of one-stage open repair using bilateral thoracotomy with successful results. The hospital mortality rate was only 2.9%, and permanent paraplegia occurred in only 1.5% of total cases. However, even in an expert institution, the pulmonary complication rate was high, with a prolonged ventilation requirement rate of 44.8% and a tracheostomy requirement rate of 14.9%. Pujara et al³ reported that chronic obstructive pulmonary disease was an independent risk factor for early death when performing open repair using left thoracotomy. For this reason, extensive one-stage open repair might be contraindicated in the present case.

The combined open surgical and endovascular two-stage approach, or “hybrid” repair, has recently emerged as a front-line treatment option for extensive thoracic aortic pathology, with successful results.⁴ However, in chronic

type B aortic dissection, endografting during thoracic endovascular aortic repair (TEVAR) with a dissected distal landing zone may be unreliable because of retrograde filling and pressurization of the false lumen. Roselli et al⁵ described a novel approach for overcoming this problem by performing open first-stage elephant trunk insertion with fenestration of the descending dissected aorta. This technique can facilitate second-stage TEVAR and eliminate retrograde filling of dissected aneurysm. Nevertheless, this technique would also be contraindicated in the present patient with dissected aortic aneurysm in which a distal landing zone was unavailable because of the tapering shape and dilation of the aneurysm.

Extra-anatomic bypass is an alternative option for a thoracic aortic aneurysm with complicated pathology.^{6,7} The avoidance of a left thoracotomy is a significant advantage of this procedure. In addition, this procedure can be applied to patients with a dissected aortic aneurysm in which a distal landing zone is not available for TEVAR, as long as a direct anastomosis to this aortic area would be possible by adjusting the caliber discrepancy between the native aorta and the vascular prosthesis. Aneurysmal isolation is a major limitation of extra-anatomic bypass. Late rupture and infection of the residual aneurysms can occur.⁸ Therefore, long-term frequent CT follow-up is necessary.

We inserted a stent graft into the true lumen of the residual aneurysm to reduce the backflow from the intercostal arteries. This plugging stent graft might contribute to aneurysmal regression and to complete thrombosis of

the residual aneurysm in the presented case. This technique should be limited to patients in whom most of intercostal and mediastinal arteries arise from the true lumen. Distribution of these arteries must be carefully evaluated before applying this technique.

CONCLUSIONS

Extra-anatomic bypass from the ascending to the descending aorta was feasible and effective for extensive dissected aortic aneurysm in a patient with pulmonary comorbidity. A plugging stent graft may reduce endoleak of the residual aneurysm and contribute to aneurysmal regression.

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