JNMS Journal of Nippon Medical School https://www.nms.ac.jp/sh/jnms/

Case Report

Debranching Thoracic Endovascular Aortic Repair (TEVAR) for Thoracoabdominal Aortic Dissecting Aneurysm Involving the Visceral Arteries: A Case Report

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Surgical repair of thoracoabdominal aortic aneurysms (TAAA) is a complex procedure that is associated with marked morbidity and mortality. Endovascular TAAA repair, initially reserved for patients at high risk, has yielded promising results and is performed on an increasing range of patients. This case report describes a hybrid approach—a combination of endovascular and open repair—for a patient with high-risk TAAA after aortic dissection. A 79-year-old man had undergone aortic replacement for chronic aortic dissection 20 years previously. His saccular TAAA, extending from the Th12 level to the renal artery origin, demonstrated progressive enlargement (56–60 mm) on computed tomography (CT) scans and compressed the celiac artery. In light of the patient's age and thoracotomy history, a hybrid repair strategy involving total debranching thoracic endovascular aortic repair (TEVAR) with four-branch abdominal reconstruction was selected to minimize surgical risk. The surgery was performed via a midline abdominal incision. Bypass surgery was first performed using a quadrant artificial graft to restore left renal, right renal, superior mesenteric, and common hepatic artery blood flow. The celiac artery was coiled, and TEVAR was completed. Intraoperative contrast and postoperative CT showed no endoleak and a patent debranching graft. The patient recovered without complications and was discharged 10 days postoperatively. The findings for the present hybrid procedure indicate that debranching TEVAR is less invasive and yields better outcomes than open aortic replacement, particularly for patients at high risk.

(J Nippon Med Sch 2026; 93 (4): 333–337. https://doi.org/10.1272/jnms.JNMS.2026_93-401)

Keywords: thoracoabdominal aortic aneurysm, aortic dissection, celiac artery, endovascular aneurysm repair

Background

Surgical repair of thoracoabdominal aortic aneurysms (TAAA) is a complex procedure and is associated with substantial morbidity and mortality, even at centers of excellence. In the past, endovascular TAAA was performed only for patients at prohibitively high surgical risk. During the past decade, however, endovascular TAAA repair has been increasingly performed for a wider cohort of patients with TAAA, and the results have been promising[1–3].

Here, we report a case of a debranching thoracic endovascular aortic repair (TEVAR) in which we attached a quadrifurcated graft inversely from the left common iliac artery to the common hepatic, superior mesenteric, and bilateral renal arteries, then performed TEVAR for TAAA after aortic dissection in a patient at high risk. The pa-

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https://doi.org/10.1272/jnms.JNMS.2026_93-401
Received: November 21, 2024; Accepted: February 21, 2025; J-STAGE Advance Publication: June 26, 2025

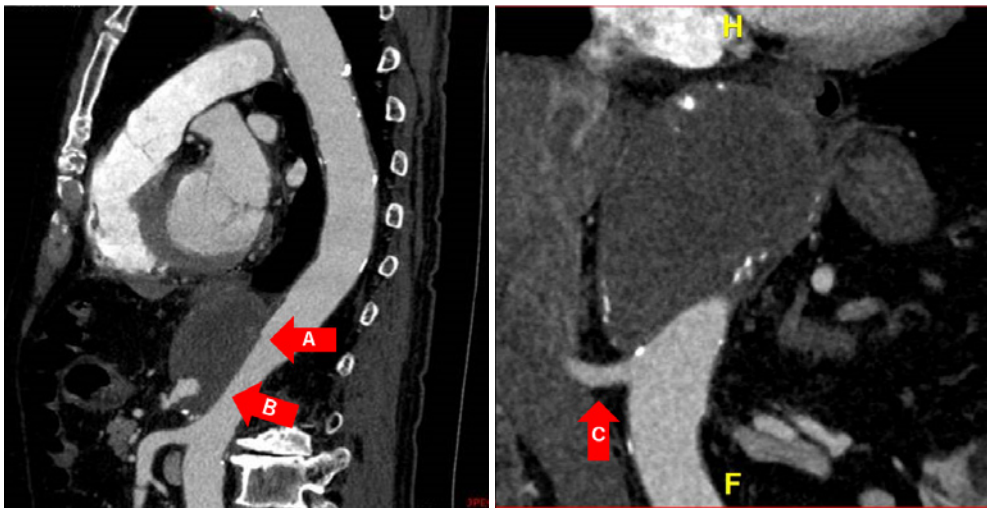

Figure 1 Preoperative CT scans
The dissecting thoracoabdominal aortic aneurysm (saccular) had a maximum short diameter of 60 mm. The arrow (A) indicates the location of the tear, which is slightly enhanced in the image. The celiac artery origin showed narrowing, as it was entrapped by the aneurysm (B). The aneurysm extended cephalad to the level of Th12 and caudally to the origin of the right renal artery (C).

tient provided informed consent for the publication of their medical information and images in this case report.

Case Presentation

A 79-year-old man had undergone left open chest descending aortic artery replacement (with the distal anastomosis performed to the true lumen) for chronic dissecting aortic aneurysm from the distal arch to the descending aorta at our hospital approximately 20 years previously. Computed tomography (CT) scanning indicated that the size of the thoracoabdominal dissecting aortic aneurysm increased during follow-up (from 56 mm at 1 year previously to 60 mm at the most recent examination), and the patient was referred to our hospital for surgery. His medical history included hypertension, surgery for benign prostatic hyperplasia, and operative gallbladder removal. Blood tests revealed a serum creatinine level of 1.19 mg/dL and estimated glomerular filtration rate of 44 mL/min/1.73 m^2, indicating severe renal dysfunction. Contrast-enhanced CT scan detected the saccular TAAA from the Th12 level and the lower end of the aneurysm extending to the renal artery origin, which was classified as Crawford III. The origin of the celiac artery was compressed and narrowed by a thrombosed and aneurysmal false lumen (**Figure 1**).

The patient was diagnosed as having a thoracoabdominal dissecting aortic aneurysm with a tendency to enlarge after distal arch to descending aortic artery replacement surgery; surgical treatment was selected. Because the patient was advanced in age and had previously undergone left open thoracotomy, open thoracotomy was considered a high risk procedure. Therefore, we planned hybrid debranching thoracic endovascular aortic repair (TEVAR) with artificial bypass of the celiac artery, mesenteric artery, and right and left renal arteries. The celiac artery origin was considered difficult to expose and ligate because it was entrapped in the aneurysm. Further, because tissue dissection around the pancreas must be minimal, we decided to coil the celiac artery origin through an endovascular approach and to bypass the common hepatic artery.

Because our patient had undergone distal arch to descending aortic artery replacement, the risk of paraplegia was considered high and a spinal drainage tube was thus inserted on the day before surgery. Fortunately, no Adamkiewicz artery was identified preoperatively at the lesion covered by the stent graft.

The surgical approach was made through a large midline abdominal incision. The retroperitoneum was incised in front of the left common iliac artery, which was then exposed along its entire length. The ligament of Treitz was dissected, the duodenum was passivated, and the central dissection was started. The right and left renal arteries, the superior mesenteric artery (SMA), and the common hepatic artery were then secured. Because the celiac artery origin was entrapped in the aneurysm, we decided to coil it endovascularly and anastomose the graft to the common hepatic artery. Anastomosis was performed in the left common iliac artery, left renal artery, right renal artery, SMA, and common hepatic artery.

The left common iliac artery was incised, and the central 16-mm portion of the artificial graft (InterGard; Getinge; Gothenburg, Sweden; 16 mm × 8 mm × 8 mm × 8 mm × 8 mm) was anastomosed with 4-0 prolene.

We decided to close the left renal artery origin with 4-0 prolene + 0 silk thread ligation, detach the left renal artery, and anastomose it end-to-end to an 8-mm graft leg of an artificial graft with 5-0 prolene because the left renal artery originated from the dorsal aorta and was too deep to anastomose directly during left renal artery anastomosis. The right renal artery and SMA just before entering the mesentery were then anastomosed end-to-side with 5-0 prolene to an 8-mm graft leg, after which the origin of the right renal artery and SMA were ligated. Prostaglandin E1 (PGE1) 2 μg was slowly infused from the artificial vascular leg to prevent SMA spasm after SMA anastomosis.

The graft leg was guided through the transverse mesentery, omental bursa, and gastric pectoralis to the common hepatic artery during common hepatic artery anastomosis. The common hepatic artery was end-to-side anastomosed to the graft leg with 5-0 prolene.

Coils were cannulated from the right femoral artery to the origin of the celiac artery, and celiac artery coiling was performed. TEVAR was placed with two devices (Gore cTag; W.L. Gore & Associates, Newark, DE, USA; 26 mm × 26 mm × 15 cm [peripheral] + 31 mm × 31 mm × 10 cm [proximal]), with the first device covering the region from 3 cm peripheral to the origin of the right renal artery and the second device covering >3 cm proximal to aneurysm. Intraoperative aortography confirmed graft patency and no endoleak of the stent graft. Operation time was 486 min, and the cross-clamp time of the left common iliac artery, right and left renal arteries, SMA, and common hepatic artery was 10–13 min. Blood transfusion was not required.

The postoperative course was uneventful. The patient was extubated in the operating room, and spinal fluid drainage and blood pressure control (mean blood pressure >90 mm Hg) were continued until 3 days postoperatively. The patient was transferred to the general ward at 4 days postoperatively, and no paraplegia, renal dysfunction, or intestinal paralysis was observed postoperatively. A CT scan obtained at 7 days postoperatively showed a well-open graft, with no evidence of endoleak or migration at the stent graft (**Figure 2**). The patient was discharged from hospital in good condition at 10 days postoperatively.

Discussion

Surgical options for TAAA that involve the major abdominal branches, as in this case, include open thoracotomy with arterial replacement, debranching TEVAR, and open-window stent grafting. Open repair is the first choice for TAAA repair[1], but surgery to replace a large aneurysm with a spiral incision and open left thoracotomy is quite invasive, and the risk of paraplegia is estimated to be approximately 10% for large aneurysms, including Crawford type 2 aneurysms. For chronic aortic dissection, the 2022 AHA/ACC guidelines recommend TEVAR, particularly for patients with evidence of progressive dissection or high rupture risk. The goal of TEVAR is to exclude the false lumen, prevent further dissection, and reduce the risk of rupture. TEVAR is also indicated for true aneurysms with a diameter larger than 5.5 cm or when rupture risk is present. Both conditions carry long-term risks, such as endoleak, thrombosis, and spinal cord injury, and close monitoring is essential after TEVAR[4]. The 2018 Society of Thoracic Surgery of Japan academic survey reported that outcomes for open repair of non-ruptured TAAA were poor in Japan, with 30-day and in-hospital mortality rates of 7.8% and 11.4%, respectively[2]. Coselli, who performed the largest number of TAAA surgeries globally, published the results for 3,309 TAAA cases in 2016. The overall in-hospital mortality rate was 7.5%, and 5.3% of patients had permanent spinal cord injury[3]. Surgical outcomes for open surgery for TAAA remain unsatisfactory, even at centers of excellence.

High-risk cases of open surgery for TAAA include patients with respiratory failure, such as chronic obstructive pulmonary disease and previous left thoracotomy, and cases of left internal thoracic artery through the thoracic cavity after coronary artery bypass. Our patient had previously undergone distal arch artificial vessel replacement during left open chest surgery; thus, another left open chest surgery was regarded as a high-risk procedure. Stent grafting may be considered instead of open surgery in such high-risk cases. Partial abdominal branch reconstruction is necessary in the case of stent grafting and involves two principal methods reconstruction: hybrid treatment with surgical debranching and open-window or stent graft with branches.

Hybrid treatment (debranching TEVAR) was selected for our patient. A bypass was placed from the common iliac artery or external iliac artery to each abdominal segment to secure blood flow (debranching) after laparotomy, and a stent graft is then deployed to cover the ab-

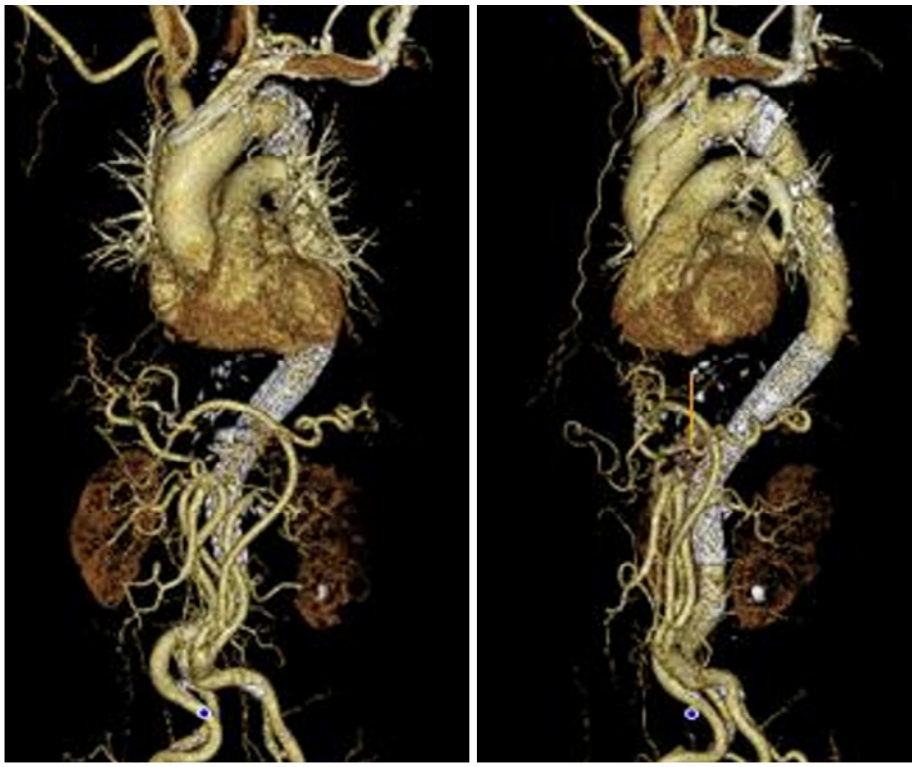

Figure 2 Postoperative 3-dimensional CT scans
The four-branch prosthetic graft passes from the left iliac artery through the left side of the abdominal aorta, and its branches are anastomosed to the left and right renal arteries, SMA, and common hepatic artery. Graft patency was good. The stent graft was inserted at 3 cm from the aneurysm centrally and peripherally. No endoleak or migration was observed at the stent graft insertion site.

dominal segment. Debranching involves opening the abdomen but is considered minimally invasive because it does not require opening the chest or clamping the aorta and reduces the duration of organ ischemia. However, many studies reported unexpectedly high perioperative mortality and paraplegia, even in high-risk patients, and complications such as artificial vessel infection and pancreatitis have been reported, indicating a need for further study[5].

A report by the Japanese Committee for Stentgraft Management found that thoracoabdominal region TEVAR was mainly performed for high-risk cases (including 17.1% of emergency cases) in combination with branch reconstruction bypass (14.0%), fenestration (12.4%), and chimney (3.1%). The in-hospital mortality rate was 11.6%, paraplegia was 2.3%, and type 1/3 endoleak was 4.2%/4.2%[6], which is considered acceptable for high-risk patients.

No branch/fenestration devices have been approved in Japan for open-window or branching stent grafts[7]. Rocha et al.[8] reported that endovascular repair was associated with improved early outcomes but higher rates of secondary procedures after discharge. Urgent introduction of branch/fenestration devices in Japan is thus required.

Conclusion

Findings from this case of debranching TEVAR for TAAA after aortic dissection in an elderly patient suggest that hybrid endovascular repair is suitable for older adults and high-risk patients.

Author Contributions: Case conception and surgical procedure: NM, AT; Data collection: AT, NM; Manuscript drafting and editing: AT, NM; Literature review: AT, NM; Critical review and revision: all authors; Final approval of the article: all authors; Accountability for all aspects of the work: all authors.

Funding: No funding was received for this study.

Conflict of Interest: The authors declare no conflicts of interest associated with this manuscript.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: The authors declare that no AI-generated content was incorporated into the manuscript.

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