Aneurysm growth after late conversion of thoracic endovascular aortic repair

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Abstract
A 69-year-old man underwent thoracic endovascular aortic repair of a descending aortic aneurysm. Three years later, he developed impending rupture due to aneurysmal expansion that included the proximal landing zone. Urgent open surgery was performed via lateral thoracotomy, and a Dacron graft was sewn to the previous stent graft distally with Teflon felt reinforcement. Postoperatively, four sequential computed tomography scans demonstrated that the aneurysm was additionally increasing in size probably due to continuous hematoma production, suggesting a possibility of endoleaks. This case demonstrates the importance of careful radiologic surveillance after endovascular repair, and also after partial open conversion.

Keywords
Descending aortic aneurysm, endovascular procedures, endoleak, endotension

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Introduction
As the number of thoracic endovascular aortic repair (TEVAR) procedures has been increasing, the long-term results including stent graft–specific complications have been reported.1,2 Here, we report a case of type 1a endoleak due to proximal neck dilatation in the chronic phase. Although open surgery was performed, the aneurysm continued to increase in size.

Case report
A 69-year-old man was referred to our hospital with acute back pain and chest discomfort. He had undergone Y-graft replacement of an abdominal aortic aneurysm 6 years ago. In addition, TEVAR for a descending aortic aneurysm had been performed 3 years ago, as described below. On admission to our hospital, computed tomography (CT) scanning showed that the proximal end of the stent graft was dislocated inside the descending aortic aneurysm, which had enlarged to a diameter of 80 mm, suggesting impending rupture (Figure 1(a) and (b)). We decided to perform open surgery because the patient wished to avoid further stenting, as well as because of the lack of urgent availability of devices at that time.

Detail of the previous surgery (TEVAR)
The patient underwent TEVAR of a descending aortic aneurysm with a maximum diameter of 67 mm at another institution. The diameter of the proximal neck was 34 mm and that of the distal neck was 27 mm. Therefore, the stent graft selected was a TAG (W.L. Gore & Associates, Inc., Flagstaff, AZ, USA) measuring 40 and 34 mm, respectively. Postoperatively, CT was conducted at discharge, 6 months, and 1 year after TEVAR. We subsequently obtained these CT scans performed before and after initial TEVAR (Figure 2). No endoleak was demonstrated, and then he stopped further follow-up himself.

Findings at open surgery and follow-up
Exposure of the thoracic aorta was obtained via left lateral thoracotomy. The proximal neck was exposed circumferentially, but the aneurysm was only partially visualized because...
of dense adhesions to the lung. The aneurysm was incised under extracorporeal circulation. Balloon occlusion using a Foley catheter via the opened aorta was done inside the stent graft to control back flow. Bleeding from the intercostal arteries was only confirmed in the healthy part of the aorta (proximal neck), and not inside the aneurysm. A Dacron graft was anastomosed to the proximal aorta and to the stent graft distally (Figure 1(c)). To suture it to the stent graft, the proximal flange was removed and the margin was reinforced with a strip of Teflon felt. The aneurysmal sac was not closed because there was no visible bleeding, as shown in Figure 1(c).

The postoperative course was uneventful and follow-up has continued for 2 years after the last procedure so far. However, postoperative sequential CT (performed 4 times) has demonstrated a continuous increase in the size of the aneurysm despite open surgery (Figure 1(d)).

Discussion

As described in the literature, possible failure after initial successful endovascular aortic repair may be due to continuing expansion of the aneurysm at the landing zone of the aorta or other morphologic changes of the aneurysm that result in a critical endoleak. This case also demonstrates that the proximal neck of the aneurysm can expand after endovascular repair and that stent seals can fail, leading to aneurysm growth. Other possibilities of this case are initially the graft deployed without appropriate landing zone, or graft migration. Although endovascular extension to exclude the proximal neck is a useful and less invasive option, we performed open surgery. Although the manufacturer’s instruction prohibits suturing of the device, this case showed that anastomosis between the TEVAR device and a Dacron prosthesis can be performed without difficulty if the device is reinforced with Teflon felt (Figure 1(c)).

Postoperatively, our patient demonstrated an inherent problem of endovascular repair, which is a gradual increase aneurysm size, despite having open surgery. A similar case has been reported by Foley et al., who encountered a patient with aneurysm expansion due to a type 1 endoleak and performed partial conversion. In their case, a proximal Dacron graft was sewn to the previous stent graft distally, and the patient was alive at 5 years despite evidence of continued aneurysm expansion. Since a continuous increase in the size of an incised aneurysm with hematoma is rarely seen after open aortic surgery with conventional prosthetic replacement, this phenomenon is probably a specific complication of stent graft or endovascular repair. Delayed aneurysm enlargement without a detectable endoleak is known as endotension, but the pressure inside the opened aneurysm

Figure 1. Computed tomography scans and operative findings. (a) and (b) Computed tomography scan on admission to our hospital: the proximal side of the stent graft (arrow) is dislocated and floating inside the aneurysm. (c) Operative findings: a Dacron graft was anastomosed to the proximal aorta and to the stent graft distally. To suture the device, the proximal flange was removed and the margin was reinforced with a strip of Teflon felt (arrows). (d) Computed tomography shows an increase in size to 94 mm 2 years after the operation with a faint onion skin pattern enhancement (asterisk).
sac would theoretically become zero in our case.\textsuperscript{3,4} Although there was no obvious contrast leakage in postoperative CT scans, continuous aneurysm growth with faint onion skin pattern enhancement in delayed phase (Figure 1(d)) suggested a possibility of endoleaks. We omitted ligation of small branches such as intercostal arteries because there was no visible blood flow inside the aneurysm sac at open surgery. There may have been continuous production of hematoma due to persistent very slight endoleaks. Therefore, we do not think that this patient is likely to develop any critical complications, such as shock due to rupture.\textsuperscript{5} However, further enlargement of aneurysm sac can lead to enlargement landing zones or deformation of the aorta, and they can lead to migration or disintegration of stent graft.\textsuperscript{5} If further enlargement occurs and re-intervention seems to be required with undetectable endoleaks, we will perform intra-arterial digital subtraction angiography with the catheter tip at different levels of the prosthesis to detect faint endoleaks. If a type 1, 3, or 4 endoleak is suspected, additional stenting should be performed. If a type 2 endoleak is detected, we would probably repeat open surgery, because endovascular methods such as coil embolization of intercostal arteries are likely to be difficult. In conclusion, this case emphasizes the importance of careful long-term radiologic surveillance after endovascular repair, even in patients with partial open conversion.

\textbf{Figure 2.} Computed tomography scans obtained before and after initial TEVAR. (a) and (b) Preoperative scans (sagittal and coronal planes) demonstrate the proximal neck of the aneurysm. (c) and (d) Follow-up scans obtained after TEVAR. There is no endoleak. The proximal landing of the stent graft shows no problems at this time.
Declaration of conflicting interests
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval
Our institution does not require ethics approval for reporting individual cases. We obtained written informed consent for patient information and images to be including in this report.

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Patient informed consent
Patient’s informed consent was obtained.

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