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Case Report

Open Conversion for Type A Ascending Aortic Dissection after Thoracic Endovascular Aortic Repair by the Chimney Graft Technique

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An 83-year-old man with aortic arch aneurysm underwent zone 0 thoracic endovascular aortic repair (TEVAR) by the chimney graft technique with two supra-aortic arch debranching grafts and developed subacute type A ascending aortic dissection. We performed emergency open conversion with circulatory arrest under deep hypothermia. The tip of the chimney graft (around the sino-tubular junction in the ascending aorta) was stiff, making it difficult to inspect the lumen and perform anastomosis. Deep hypothermic circulatory arrest and cutting the endograft stents to mobilize the graft were necessary for secure anastomosis.

Keywords: thoracic endovascular aortic repair, chimney graft technique, type A aortic dissection

Introduction

Thoracic endovascular aortic repair (TEVAR) has been increasingly performed in patients with thoracic aortic aneurysm, particularly those considered at high risk for conventional open aortic repair using extracorporeal circulation. In patients with aortic arch lesions, the use of hybrid repair has also been increasing, such as performing total debranching TEVAR via sternotomy.[1,2] To minimize surgical invasion, the chimney graft technique was introduced as a method of total endovascular arch repair for poor risk patients.[3,4] This technique avoids sternotomy and side-clamping of the ascending aorta for proximal anastomosis, which may lead to serious complications such as stroke or aortic dissection.[5] However, increasing clinical experience with endograft deployment has highlighted the potential risk of retrograde type A aortic dissection.[5,6]

Case Report

An 83-year-old man was referred for surgical treatment of a saccular aortic arch aneurysm that presented with the symptom of hoarseness. We performed hybrid repair because he was relatively old for open arch repair. The diameter of the ascending aorta was 36 mm. We combined endovascular repair (Gore TAG 40 mm; W. L. Gore & Associates, Flagstaff, AZ, USA) with a chimney graft (Excluder contralateral leg 14 mm; W. L. Gore & Associates), following two supra-aortic arch debranching grafts with extra-anatomical reconstruction using an 8-mm ringed ePTFE prosthesis. The length of the proximal landing zone was 70 mm, including the chimney graft of 61 mm in length (the tip of the chimney graft to the ostium of the innominate artery). On postoperative day 6, coli embolization of the left subclavian artery was performed due to a residual type II endoleak, and the patient was subsequently discharged with the ability to perform his usual daily activities.

However, he was readmitted on postoperative day 20 with chest discomfort and fatigue. Computed tomography

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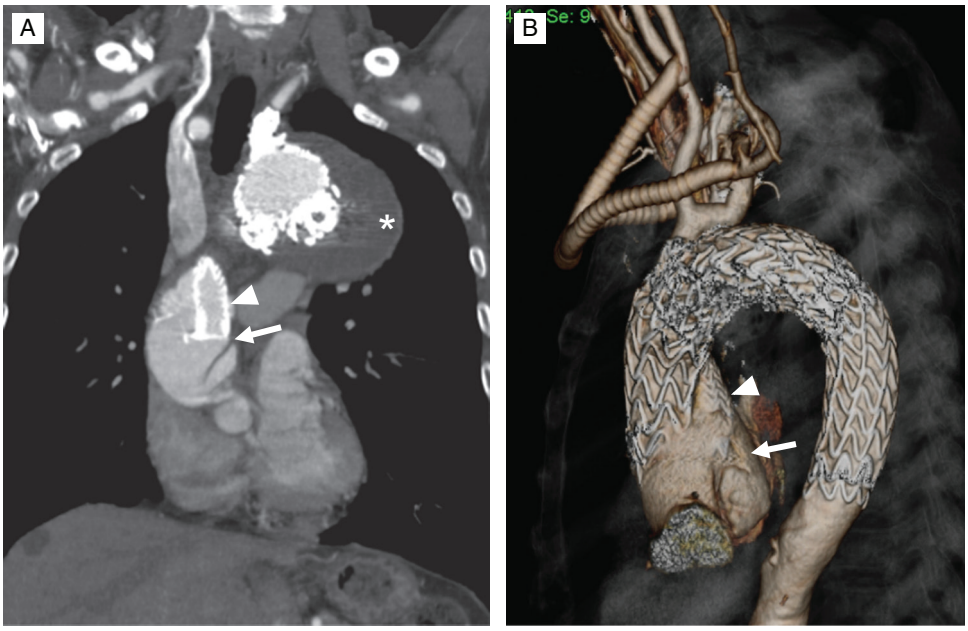

Fig. 1 (**A**) Coronal CT scan at 20 days after endovascular aneurysm repair with a chimney graft. The asterisk indicates the almost completely thrombosed aneurysm sac, while the arrow indicates a new type A ascending aortic dissection. The arrow head indicates the chimney graft. (**B**) Three-dimensional image. CT: computed tomography

(CT) revealed type A aortic dissection (**Fig. 1**). We performed emergency open surgery with circulatory arrest under deep hypothermia (16°C). Access was obtained via a moderate-sized median sternotomy to prevent injury to the ePTFE graft running along the sternum. Cardiopulmonary bypass was established after femoral artery and direct caval cannulation, and body temperature was reduced. After aortotomy, the proximal portion of the bare metal stents around the sino-tubular junction was stiff and difficult to mobilize to allow inspection of the lumen. Three stents (roughly 30 mm) were cut from the main endograft and several stents were cut from the chimney graft, allowing the entry tear to be visualized and the distal anastomosis to be mobilized (**Figs. 2A** and **2B**). The entry tear was seen along the proximal part of the chimney graft (along the gutter), and the false lumen was extended retrogradely involving the non-coronary sinus of Valsalva. After the entry tear was excised, the distal margin of the native aorta was reinforced with Teflon felt in sandwich fashion. A Dacron graft (30 mm in diameter) was anastomosed to the proximal aorta at the sino-tubular junction, and was anastomosed to the distal ascending aorta with felt reinforcement, as described above, but not to the endograft. The postoperative course was uneventful and he has remained asymptomatic for 3 years after surgery (**Figs. 3A** and **3B**).

Discussion

There have been several recent developments in endovascular aortic repair, including the use of custom-made branched or fenestrated stent grafts for a total endovascular approach. During the last decade, we have performed zone 0 TEVAR with total arch debranching or use of a chimney graft as less invasive procedures.[1,3,4] Accumulation of data has shown that TEVAR, including total arch debranching, is associated with an increased risk of retrograde type A aortic dissection.[2,5,6] This is usually an acute complication, but sometimes occurs in the chronic phase.[5] Performing aortic side clamping for proximal re-routing anastomosis, compliance mismatch between the endograft and the ascending aorta, and alteration in blood flow by the re-routing itself may be associated with retrograde type A aortic dissection.[2] TEVAR-related factors that may also increase the risk of retrograde type A aortic dissection include use of zone 0 as the proximal landing zone, an ascending aortic diameter ≥4.0 cm, use of an excessively oversized stent, and aggressive balloon dilatation.[5,6,7] Although there have been few case reports of type A aortic dissection after chimney graft deployment, it may not be surprising for this complication to occur because balloon dilatation of the ascending aorta is frequently performed to prevent

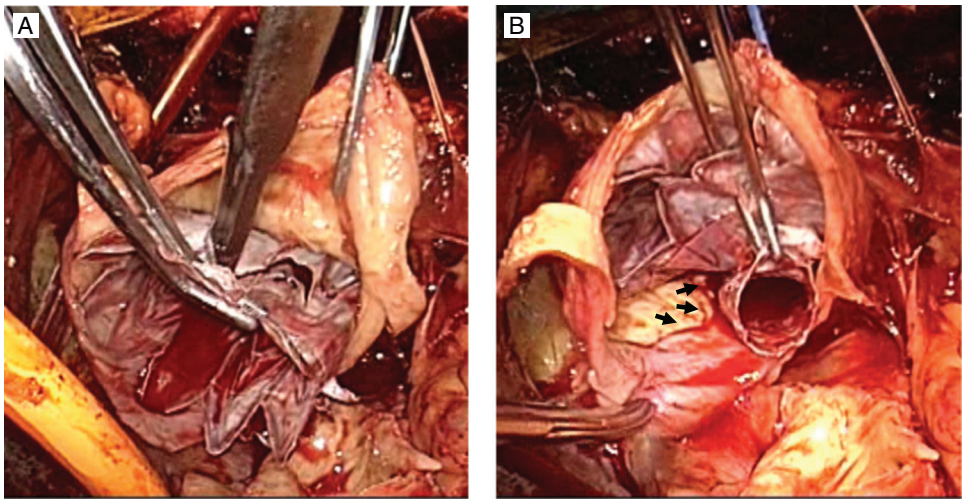

Fig. 2 (**A**) Intraoperative photograph after transection of the ascending aorta. Cutting several stents allowed mobilization of the chimney graft and an aortic cuff was fashioned with reinforcement by felt strips. (**B**) Arrows indicate the entry tear located along the proximal part of the chimney graft.

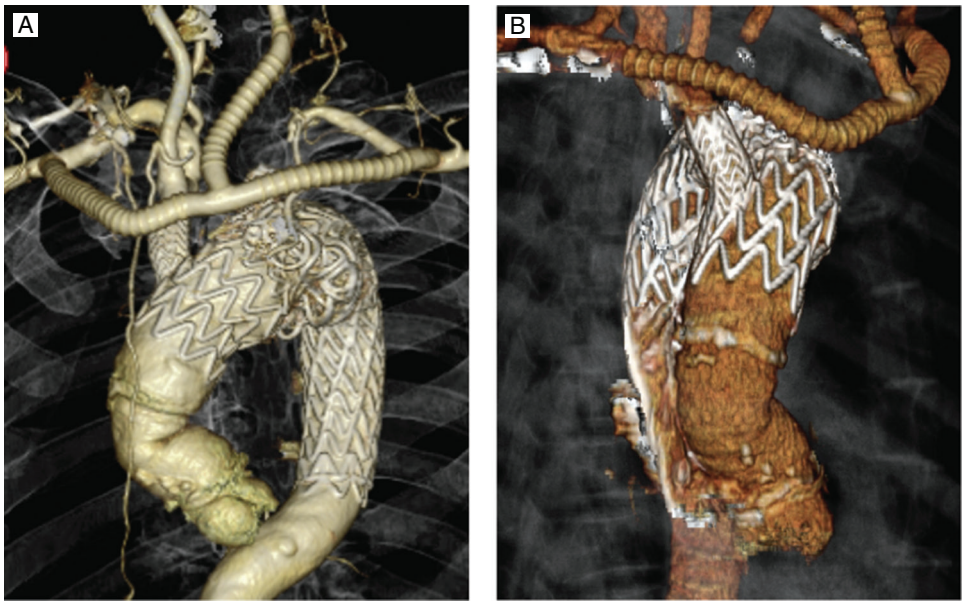

Fig. 3 CT scan at 1 year after open conversion. The proximal stent of the main endograft with the chimney graft was tapered for anastomosis to the Dacron graft, probably preventing the occurrence of type 1a endoleak. (**A** and **B**) Three-dimensional images vary in an angle. CT: computed tomography

gutter leaks and an excessively oversized main endograft may be selected to create a lateral channel of the "chimney".[4] The entry tear was seen along the chimney graft in this case.

The present case is an example of escaping from catastrophic complications. There were several difficulties, including a prosthesis running along the sternum, no reasonable option for establishing selective antegrade cerebral perfusion, and the anastomotic site of the ascending aorta being too stiff to move due to the bare metal stents although adhesions around the ascending aorta after endovascular repair are expected to some extent. Aortic cross-clamping must be avoided in patients with type A aortic dissection after endovascular repair

with the chimney graft method. We used deep hypothermia for cerebral protection, but an alternative would be cerebral perfusion via the chimney graft using a relatively large-diameter balloon catheter. For other methods, the debranching graft on the sternum can be divided and two balloon catheters can be independently inserted to establish antegrade cerebral perfusion under balloon occlusion in the chimney graft, but the procedure may be burdensome since it includes peeling off the graft and re-anastomosis at the sternum. There is also a risk of wound infection. Performing antegrade cerebral perfusion with a balloon catheter via the chimney graft is also not easy in the narrow anastomotic space.

To achieve reliable anastomosis in our patient, removing the proximal portion of the endograft including cutting the proximal parts of the bare metal stents with metal hooks was necessary to allow mobilization of the anastomotic site, closure the entry tear, and facilitate secure suturing because the ascending aorta was stiff and fixed within the chimney graft.[8] Although concerns have emerged regarding the risk of postoperative type 1a endoleak in patients with chimney grafts, this has not occurred during follow-up for 3 years. The main stent was a 40 mm Gore-TAG and it was tightly anastomosed to a 30 mm Dacron graft by tapering the proximal stent, probably leading to close adhesion to the aortic wall that prevented type 1 endoleak (**Fig. 3**).

Conclusion

Although the chimney graft technique is a less invasive option for zone 0 TEVAR, there is a potential risk of type A aortic dissection. To salvage our patient, deep hypothermic circulatory arrest and cutting the endograft stents to mobilize the graft were necessary for secure anastomosis.

Disclosure Statement

None.

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