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Total Aortic Arch Endograft and Double In Situ Fenestration for Aortobronchial Fistula

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This case highlights the challenges of treating an aortobronchial fistula. Emergent total aortic arch stent grafting is limited by inability to maintain cerebral perfusion during in situ fenestration. We describe the application of a new technique to maintain cerebral perfusion using a gutter balloon adjacent to the aortic endograft while great vessel fenestrations are being performed in an urgent setting.

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Cerebral perfusion is critical during complete aortic arch stent grafting. Whereas custom total arch devices are available in elective settings, the treatment of emergent conditions such as aortobronchial fistula has traditionally been limited to open repair. As a result, palliation is often offered to patients who are poor open operative candidates and whose pathologic process requires total arch endograft coverage. This report demonstrates that total endovascular aortic arch repair with in situ fenestration is a feasible solution for poor open surgical candidates with an otherwise fatal acute aortic arch syndrome.

An 85-year-old man presented with large-volume hemoptysis. This occurred in the context of recurrent methicillin-sensitive *Staphylococcus aureus* bacteremia of unknown source, requiring 2 admissions and cefazolin treatment in the preceding 4 months. Computed tomography angiography demonstrated a large saccular aneurysm of the mid aortic arch protruding into the left upper lobe with inflammatory features, consistent with mycotic aortobronchial fistula (Figure 1A).

His past medical history was notable for smoking, and he lived independently but required assistance for activities of daily living. He was deemed unfit for emergent open aortic arch repair but remained keen to pursue any lifesaving intervention. Because of the proximity of the aneurysm in the aortic arch, standard thoracic endovascular aortic repair (TEVAR) solutions with extra-anatomic debranching were not possible, and the delay required to procure a custom branched endograft was inappropriate. Owing to the urgency of his condition, we proceeded with urgent zone 0[1] TEVAR with retrograde in situ branched stent grafting, which relies on a "gutter balloon" to maintain cerebral perfusion during in situ fenestration.[2]

Bilateral radial arterial line, cerebral oximetry monitors, and double-lumen endotracheal tube were established. We surgically exposed bilateral common carotid arteries, percutaneously accessed bilateral femoral and right axillary arteries, and percutaneously accessed the right femoral vein for temporary inferior vena cava (IVC) balloon occlusion.

From the right axillary access, we advanced a 12 × 40-mm gutter Mustang balloon (Boston Scientific) into the ascending aorta. With this balloon inflated in the aorta just proximal to the innominate origin, we deployed a TEVAR graft across the aortic arch from zone 0 to zone 4 (Gore conformable thoracic branch endoprosthesis, 37 × 37 × 200 mm) with IVC balloon occlusion cardiac output suppression. Uninterrupted cerebral perfusion through the gutter leak created by the parallel zone 0 gutter balloon was confirmed by cerebral oximetry, bilateral radial arterial lines, and angiography (Figure 2A).

We then advanced a Chiba needle (Cook Medical, 18 gauge, 20 cm in length) retrograde through the left carotid artery 9F sheath, over an Amplatz wire (Boston Scientific). Under fluoroscopy, this needle punctured the aortic graft at the origin of the left carotid, and the Amplatz wire was subsequently advanced into the aortic root. This fenestration was predilated with a 6 × 20-mm

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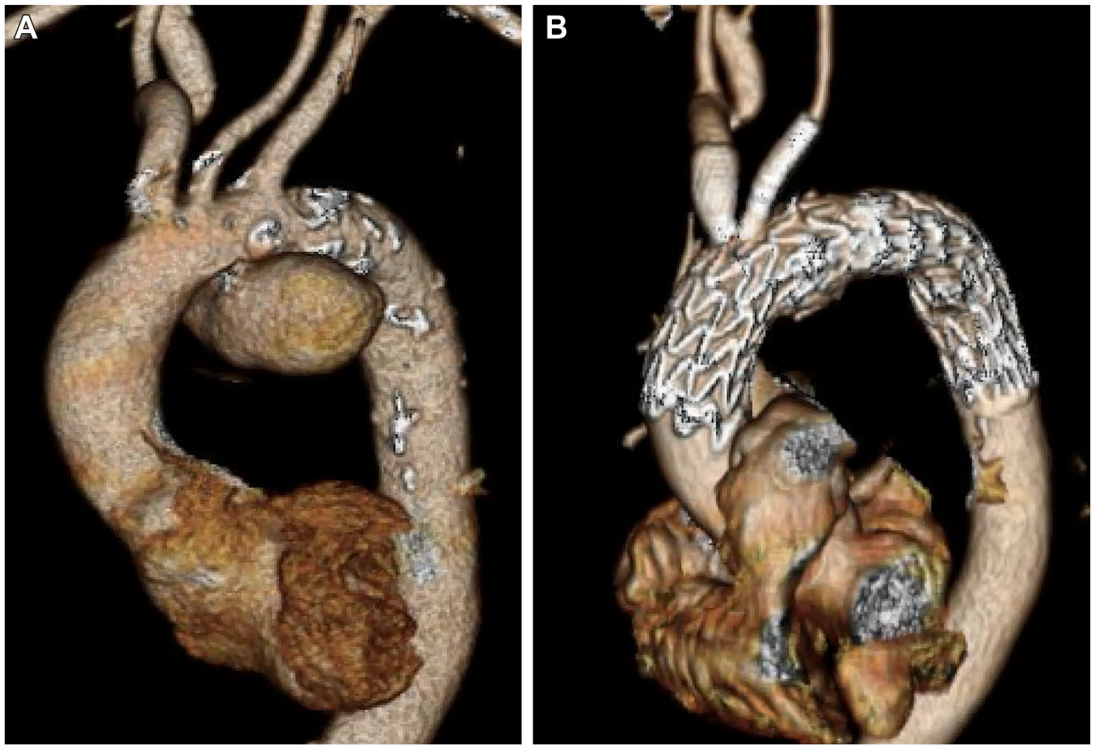

FIGURE 1 Computed tomography angiography images demonstrating (A) preoperative saccular aneurysm and (B) postoperative in situ fenestrated endograft excluding the aneurysm.

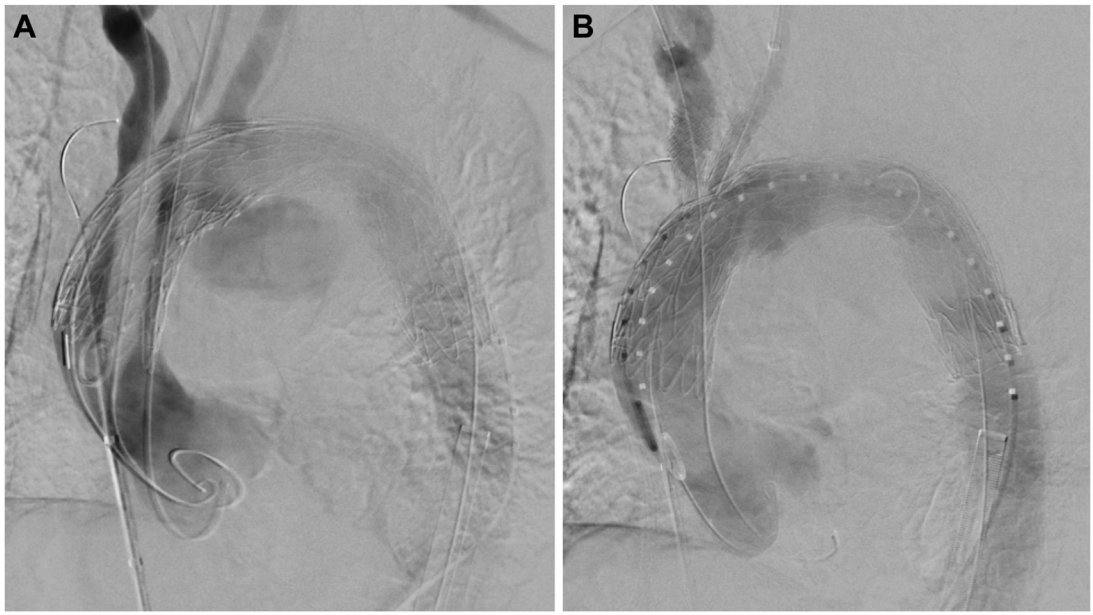

FIGURE 2 (A) Intraoperative angiographic image of the gutter balloon maintaining great vessel perfusion despite zone 0 aortic endograft deployment. (B) Completion angiogram confirming patency of the innominate and left carotid arteries with aneurysm exclusion.

high-pressure Athletis balloon (Boston Scientific) and secured with 80 × 59-mm VBX stent graft (Gore), post-dilated proximally with an 8 × 20-mm Athletis balloon.

The innominate in situ fenestration was then created in a similar manner through the right carotid, only withdrawing the gutter balloon after predilation of this second fenestration with a 6 × 20-mm Athletis balloon. Again, we used an 80 × 59-mm VBX stent for the innominate fenestration, flaring distally with a 14 × 40-mm balloon to seal the innominate artery. We performed kissing balloon angioplasty of both in situ fenestration VBX grafts. Completion angiography demonstrated patent innominate and left carotid stents and exclusion of the aneurysm (Figure 2B) corroborated by transesophageal echocardiography.

He was noted to have a low left radial arterial pressure of 30 mm Hg, with known diminutive left vertebral artery. We therefore performed a left carotid-to-subclavian bypass using an 8-mm ringed Propaten graft (Gore). Throughout the case, cerebral oximetry and the right radial arterial line were suppressed only during in situ fenestration ballooning, which was limited to 10 seconds per fenestration.

He was extubated the same day, cognitively intact and moving all extremities. He had no postoperative episodes of hemoptysis. On postoperative day 1, left leg weakness developed. Computed tomography angiography demonstrated no endovascular reconstruction abnormalities, including widely patent stents and exclusion of the aneurysm (Figure 1B). Subsequent magnetic resonance imaging demonstrated bilateral small acute infarcts consistent with a central embolic source. There was also a focal right carotid dissection at the access site, which we ultimately elected to repair with bovine pericardial patch on postoperative day 5 to maximize cerebral perfusion and to eliminate it as a potential source of more emboli.

He continued to recover and was discharged with full function of both arms, independently ambulating with a walker. Lifelong oral antibiotics were prescribed.

COMMENT

Aortobronchial fistula is a life-threatening emergency that poses numerous surgical challenges. There are a constellation of treatment solutions for this complex problem.[3] Open surgical repair involving aortic reconstruction and lobectomy is a physiologically demanding operation. Many authors have therefore pursued endovascular treatment alternatives. Whereas total endovascular aortic arch repair has recently emerged in the elective setting, this typically relies on custom stents with prefabricated fenestrations that maintain uninterrupted cerebral perfusion. Custom devices are not available emergently, and alternative techniques such as in situ fenestrations are required.

In situ aortic arch endograft fenestration typically involves only partial aortic arch coverage with uninterrupted innominate artery perfusion and has been performed successfully in zone 1 for an aortobronchial fistula.[4] A fundamental limitation of zone 0 TEVAR in situ fenestration is total cerebral hypoxia. Although a single-branch in situ fenestration for aortoenteric fistula has been reported, it required a period of complete cerebral anoxia during in situ fenestration of the innominate branch.[5] Unfortunately, that patient suffered a dense stroke.

A year later, Ohki and colleagues[2] published a complete aortic arch in situ fenestration technique that maintains uninterrupted cerebral perfusion using a gutter balloon. Our case leverages the concept of this retrograde in situ branched stent grafting technique by using readily available off-the-shelf devices in an emergent scenario necessitating complete aortic arch coverage.

Our patient suffered a postoperative day 1 bilateral embolic stroke, with eventual functional recovery. The precise mechanism remains unclear; however, the embolic pattern cannot be explained exclusively by cerebral hypoperfusion. Stroke remains a significant risk during endovascular arch reconstruction.[6] Another limitation of any endovascular treatment of mycotic aneurysms is infection of the prosthetic endograft. In the context of the palliative alternative, we consider long-term antibiotics an acceptable sequela.

In summary, total endovascular aortic arch repair with in situ fenestration is a feasible solution for patients who are not open surgical candidates with an otherwise fatal acute aortic arch syndrome.

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PATIENT CONSENT
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REFERENCES

1. Upchurch GR Jr, Escobar GA, Azizzadeh A, et al. Society for Vascular Surgery clinical practice guidelines of thoracic endovascular aortic repair for descending thoracic aortic aneurysms. *J Vasc Surg*. 2021;73:55S-83S.

2. Ohki T, Maeda K, Baba T, et al. Early clinical outcomes of retrograde in situ branched stent grafting for complex aortic arch aneurysms. *J Vasc Surg*. 2022;75:803-811.e2.

Ann Thorac Surg Short Reports
2024;2:11-14

3. Anastasiadou C, Trellopoulos G, Kastora S, et al. A systematic review of therapies for aortobronchial fistulae. *J Vasc Surg*. 2022;75:753-761.e3.

4. Nana P, Le Houérou T, Gaudin A, Guihaire J, Fabre D, Haulon S. In situ fenestrated thoracic endovascular repair using the upstream peripheral Go Back re-entry catheter. *J Endovasc Ther*. Published online January 9, 2023.

5. Lee S, Srinivasa RN, Rigberg DA, Yanagawa J, Benharash P, Moriarty MJ. Aortoesophageal fistula involving the central aortic arch salvaged with emergent percutaneous TEVAR, great vessel coverage and in vivo graft fenestration. *Diagn Interv Radiol*. 2021;27:122-125.

6. Rommens KL, Estrera AL. Contemporary management of aortic arch aneurysm. *Semin Thorac Cardiovasc Surg*. 2019;31:697-702.