

Total debranching thoracic endovascular aortic repair with elephant trunk insertion technique

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ABSTRACT

We report successful total debranching thoracic endovascular aortic repair using the elephant trunk insertion technique without hypothermic circulatory arrest for a 56-year-old man who developed aortic arch dissection and ascending aortic aneurysm. In the first step, an elephant trunk graft was inserted into the ascending aorta under cardiopulmonary bypass, and a branched prosthetic graft was attached to the ascending aorta. The left common carotid artery and brachiocephalic artery were sequentially anastomosed to the branched graft. The second step was thoracic endovascular aortic repair covering the elephant trunk to the distal arch. Postprocedure digital subtraction angiography showed no endoleaks or false lumen. (*J Vasc Surg Cases and Innovative Techniques* 2020;6:626-8.)

Keywords: TEVAR; Aortic dissection; Zone 0

Hypothermic circulatory arrest (HCA) is a standard technique for open aortic surgery, although its operative complications, especially brain stroke, are still a major concern.¹ Total debranching thoracic endovascular aortic repair (TEVAR) has recently been applied for aortic arch aneurysms,² because surgical stress with TEVAR is lower than that with HCA.³ However, performing a zone 0 TEVAR is difficult in patients with ascending dilation. We herein report the successful performance of total debranching TEVAR using the elephant trunk insertion technique without HCA. Written informed consent was obtained from the patient for the publication of this report.

CASE REPORT

A 56-year-old man with a history of conservative therapy for Stanford B type aortic dissection (12 years earlier) and hypertension was transferred to our department with a chief complaint of back pain. A contrast-enhanced computed tomography (CT) scan revealed a new aortic arch dissection at the old false lumen; the major entry was located between the left common carotid artery (CCA) and left subclavian artery (SCA), the maximum arch diameter was 60 mm, and the distal ascending aorta diameter was 49 mm (Fig 1, A). Echocardiography revealed

an aortic root diameter of 39 mm and confirmed that the aortic valve was intact.

The diagnosis was an acute aortic arch dissection that had developed in a chronic aortic dissection and ascending aortic dilation. His back pain persisted despite intensive blood pressure control in the intensive care unit. He was at high risk for aortic rupture. Total arch replacement with HCA was suggested. However, he declined this option because of concern regarding HCA-related brain complications. We believed that a sufficient landing zone could be prepared with an elephant trunk graft inserted in the ascending aorta and offered him total debranching TEVAR as an alternative.

We planned a stepwise operation. The first step was elephant trunk insertion and neck vessel translocation (Video). We established regular cardiopulmonary bypass with right common femoral artery perfusion and bicaval drainage. A vent catheter was inserted via the right superior pulmonary vein to the left ventricle. The aorta was occluded, and hypothermic cardioplegic solution was administered via a catheter in the ascending aorta to ensure total electromechanical arrest. Although the length of the ascending aorta from the coronary orifice to the brachiocephalic artery (BCA) was 7.4 cm, the length of the working space in the aorta from the incision to the aortic clamp measured approximately 4 cm. A ϕ 30-mm, 5-cm-long Triplex graft (TERUMO Co, Tokyo, Japan) was folded and inserted into the partial aortic incision (Fig 2, A). The proximal side of the inserted graft was attached to the inner circumferential aortic wall using continuous 4-0 polypropylene sutures (Fig 2, B). A branched graft (12 \times 8 \times 8 mm) was attached to the incision in the ascending aorta before declamping of the aorta. The left CCA and BCA were sequentially anastomosed to branched grafts of ϕ 8 mm and ϕ 12 mm, respectively (Fig 2, C). The proximal sides of the left CCA and BCA were ligated. The patient was weaned from cardiopulmonary bypass, and the chest was closed. The minimum nasopharyngeal temperature was 31.5°C, and the aortic cross clamp time was 61 minutes. Left CCA-left SCA bypass was performed using an ϕ 8-mm vascular graft.

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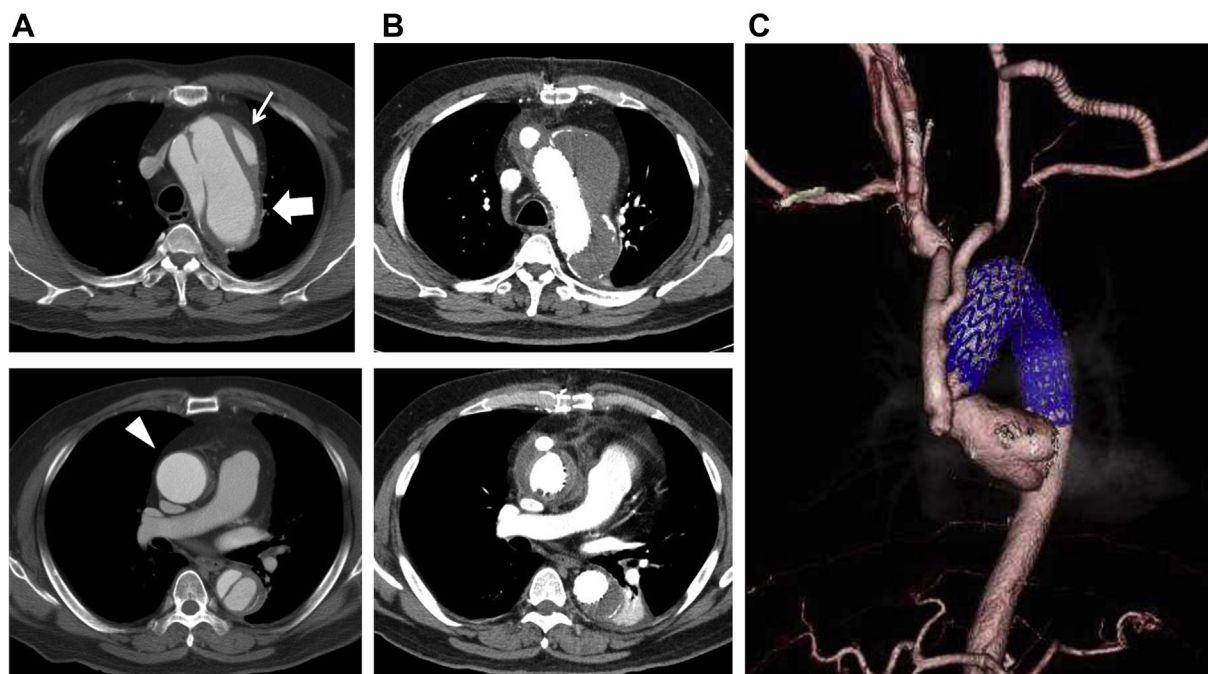


Fig 1. Computed tomography (CT) image. **A**, Preoperative images show a new aortic arch dissection (*narrow arrow*) at the old false lumen (*wide arrow*) and ascending aorta dilation ($\phi 49$ mm, *arrowhead*). **B**, Postoperative images show remodeling of the aortic dissection and no evidence of an endoleak. **C**, Postoperative three-dimensional image shows the patent grafts and zone 0 landing stent graft.

The second step was TEVAR in a single setting. A guide-wire was delivered to the inside of the elephant trunk under intravascular ultrasound guidance. A thoracic stent graft (cTAG 31 \times 100 mm; W. L. Gore & Associates Inc., Flagstaff, Ariz) was introduced from the right common femoral artery and deployed into the zone 4 thoracic descending aorta (Fig 2, D). A second stent graft (cTAG 37 \times 200 mm) was deployed into the zone 0 ascending aorta under rapid pacing. The tip of the cTAG was shorter than any other devices, which prevented aortic valve disruption. The stent graft's proximal edge was opened above the neck bypass orifice. The left SCA was embolized with a $\phi 16$ -mm plug. Final digital subtraction angiography showed no endoleak or false lumen.

The patient was transferred to the intensive care unit in stable condition. One month later, contrast-enhanced CT showed shrinkage of the false lumen and no endoleak (Fig 1, B and C). Seven months postoperatively, CT showed no aortic root dilatation or anastomotic pseudoaneurysm.

DISCUSSION

Generally, the treatment for ascending and arch aortic aneurysm requires circulatory arrest and open aortic anastomosis under deep or moderate hypothermia with or without antegrade brain perfusion. Such techniques are effective circulation management strategies in several reports.⁴⁻⁷ However, when patients decline

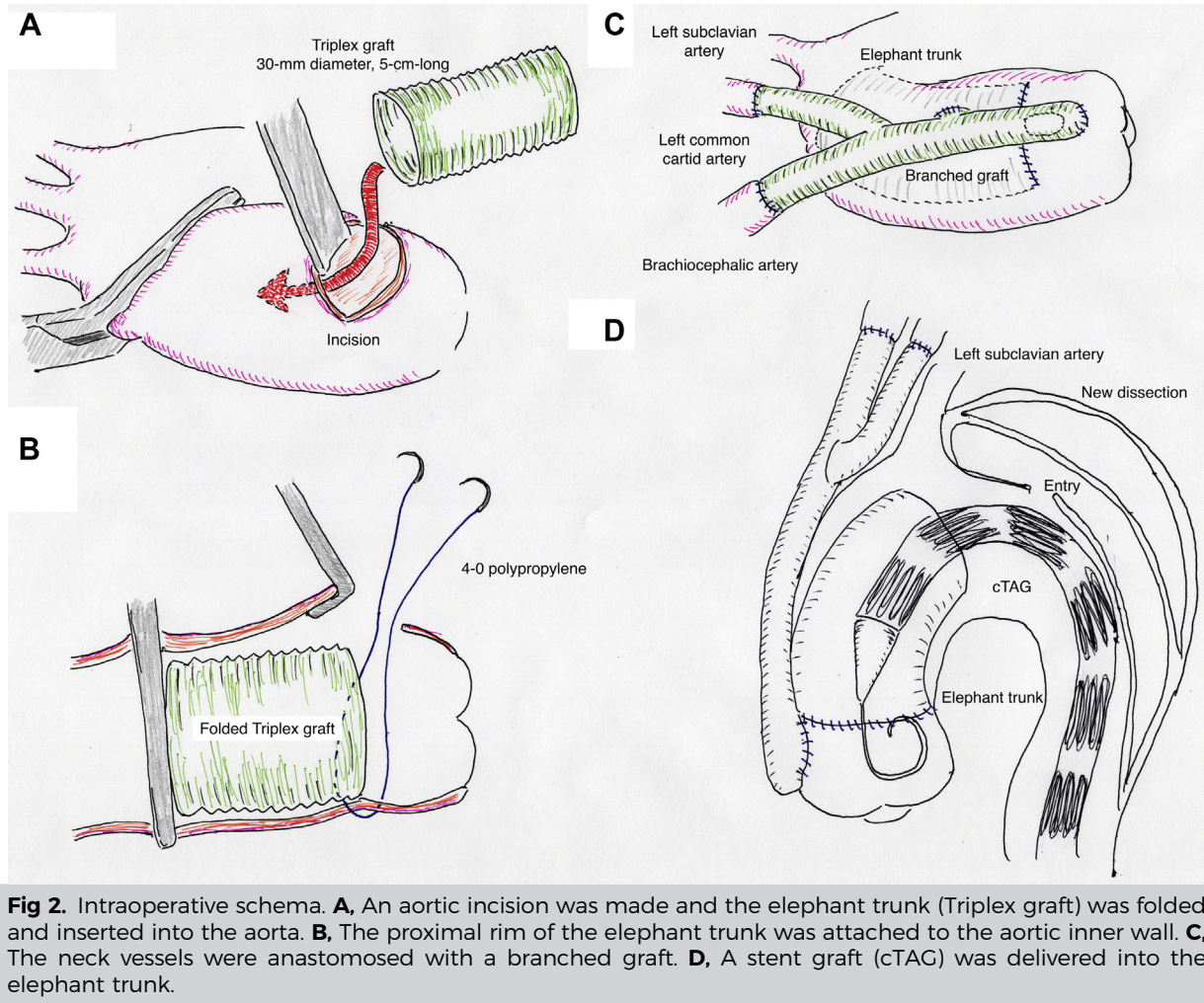
aortic surgery under HCA, we should present an alternative plan.

Our method has several merits. First, this technique is advantageous in terms of avoiding circulatory arrest. Second, the landing zone is longer in the elephant trunk technique than in ascending aorta graft replacement. Third, the risk of suture line bleeding is decreased because the ascending aorta is not transected completely.

Compared with open surgery for elephant trunk completion as a second-stage procedure, endovascular surgery is associated with reduced stroke rates, transfusion volume, and hospital stay.⁸ In addition, TEVAR with previous thoracic surgery is not associated with an increased risk of 30-day mortality or spinal cord ischemia.⁹ Performing zone 0 TEVAR with this technique, we obtained a good short-term outcome with remodeling of the aortic dissection and no evidence of endoleak. However, long-term results, especially the residual risk of aneurysm at the aortic root and ascending aorta, remain unclear; therefore, longitudinal follow-up is necessary.

CONCLUSIONS

We conducted zone 0 TEVAR with the elephant trunk as a rescue operation for treatment of an aortic arch dissection and obtained good short-term results.



REFERENCES

1. Tian DH, Wan B, Bannon PG, Misfeld M, LeMaire SA, Kazui T, et al. A meta-analysis of deep hypothermic circulatory arrest alone versus with adjunctive selective antegrade cerebral perfusion. *Ann Cardiothorac Surg* 2013;2:261-70.
2. Mizuno T, Hachimaru T, Oi K, Watanabe T, Kuroki H, Fujiwara T, et al. Easy and safe total debranching of aneurysms using axilloaxillary arterial bypass. *Ann Thorac Surg* 2015;100:1476-8.
3. De Rango P, Cao P, Ferrer C, Simonte G, Coscarella C, Cieri E, et al. Aortic arch debranching and thoracic endovascular repair. *J Vasc Surg* 2014;59:107-14.
4. Leshnowar BG, Thourani VH, Halkos ME, Sarin EL, Keeling WB, Lamias MJ, et al. Moderate versus deep hypothermia with unilateral selective antegrade cerebral perfusion for acute type A dissection. *Ann Thorac Surg* 2015;100:1563-9.
5. Gong M, Ma W, Guan X, Wang LF, Li JC, Lan F, et al. Moderate hypothermic circulatory arrest in total arch repair for acute type A aortic dissection: clinical safety and efficacy. *J Thorac Dis* 2016;8:925-33.
6. Poon SS, Estrera A, Oo A, Field M. Is moderate hypothermic circulatory arrest with selective antegrade cerebral perfusion superior to deep hypothermic circulatory arrest in elective aortic arch surgery? *Interact Cardio Vasc Thorac Surg* 2016;23:462-8.
7. Vallabhajosyula P, Jassar AS, Menon RS, Komlo C, Gutsche J, Desai ND, et al. Moderate versus deep hypothermic circulatory arrest for elective aortic transverse hemiarch reconstruction. *Ann Thorac Surg* 2015;99:1511-7.
8. Roselli EE, Subramanian S, Sun Z, Idrees J, Nowicki E, Blackstone EH, et al. Endovascular versus open elephant trunk completion for extensive aortic disease. *J Thorac Cardiovasc Surg* 2013;146:1408-17.
9. King RW, Wooster MD, Ruddy JM, Genovese EA, Anderson JM, Brothers TE, et al. Previous thoracic aortic repair is not associated with adverse outcomes after thoracic endovascular aortic repair. *J Vasc Surg* 2020;71:1097-108.

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