Hybrid Repair for Ruptured Thoracic Aortic Aneurysm: Frozen Elephant Trunk Technique with Thoracic Endovascular Aortic Repair

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We present a case of ruptured thoracic aortic aneurysm (TAA) with type B aortic dissection in which hybrid repair, namely, the frozen elephant trunk (FET) technique with thoracic endovascular aortic repair (TEVAR), was performed. The TAA extended to the proximal descending aorta at the level of the pulmonary trunk bifurcation. We thus employed the FET technique to control the blood flow into the TAA. After performing the FET technique, intraoperative catheter aortography revealed slight type 1B endoleak. We therefore performed additional TEVAR to control the blood flow into the TAA. The patient’s postoperative course was uneventful.

Keywords: frozen elephant trunk, aortic dissection

Introduction

Rupture of the thoracic aortic aneurysm (TAA) is a life-threatening condition that requires emergency surgery. Conventional open surgical repair of ruptured is associated with high mortality rates, and a considerable number of surviving patients suffer from disabling complications. We present a case of ruptured TAA with type B aortic dissection in which hybrid repair, namely, the frozen elephant trunk (FET) technique with thoracic endovascular aortic repair (TEVAR), was performed.

Case Report

A 65-year-old man was admitted to our hospital because he had experienced sudden syncope. On admission, he was hemodynamically unstable (arterial pressure: 70/50 mmHg), and transthoracic echocardiography (TTE) revealed large pericardial effusion. Enhanced computed tomography (CT) revealed large pericardial effusion, mediastinal hematoma, 60 mm of a TAA at the aortic arch, and type B aortic dissection with a patent false lumen in which the entry tear was located in a distal site of the TAA (Fig. 1). We diagnosed the patient with rupture of the TAA with type B aortic dissection and cardiac tamponade. The TAA extended from the top of the aortic arch to the proximal descending aorta at the level of the pulmonary trunk bifurcation. We carried out a total arch replacement (TAR) using the FET technique. We planned to perform additional TEVAR to control the blood flow into the aneurysm if a retrograde false lumen flow or endoleak was observed.

Our FET technique was described in a previous report.1) The patient’s pericardial cavity was found to be filled with blood. Total cardiopulmonary bypass (CPB) was thus initiated, and the patient’s hemodynamics was stabilized. After the rectal temperature decreased to 28°C, selective cerebral perfusion was initiated. Next, the aorta was incised longitudinally to just proximal of the aneurysm. We could find the rupture site at the lesser curvature of the aortic arch, and the intimal tear at the distal site of the aortic arch. We inserted the FET (Frozenix®, Japan Lifeline, Tokyo, Japan) in the true lumen of the descending aorta, ensuring that it was not positioned beyond the aortic valve level of the descending aorta. A synthetic graft with four branches was anastomosed end-to-end at the stump of the aortic arch including the aortic wall and the FET. Next, we reconstructed the neck vessels and the ascending aorta. After weaning the patient from CPB, we carried out catheter aortography to evaluate whether the
blood flow into the aneurysm was completely controlled. Aortography revealed slight type 1B endoleak and no retrograde false lumen flow. Thus, we performed additional TEVAR (Gore TAG®, W. L. Gore & Associates, Inc., Flagstaff, AZ, USA). The length of the stent graft was 10 cm and the distal end of the stent graft was T7. The endoleak subsequently disappeared (Fig. 2). The patient’s postoperative course was uneventful, and enhanced CT after surgery revealed a good shield of the aneurysm, expansion of the true lumen, and complete thrombosis of the false lumen (Fig. 3).

Discussion

Rupture of the TAA is a life-threatening condition that requires emergency surgery. Recently, a number of cases of stent grafting for the treatment of TAA rupture have been reported, including total debranching or chimney grafting for cases of arch aneurysm. Total debranching TEVAR carries a risk of overt rupture because it is performed under conditions of heparinization and uncontrolled blood pressure. In the case described herein, the patient had a ruptured TAA with type B aortic dissection and cardiac tamponade. We judged that it would be difficult to perform a conventional graft replacement because the TAA extended from the top of the aortic arch to the proximal descending aorta at the level of the pulmonary trunk bifurcation. Further, total debranching was needed to perform TEVAR despite the patient’s unstable hemodynamic status. Thus, we performed a TAR using the FET technique for two reasons. First, by deploying the FET in the true lumen, we thought that the blood flow into the TAA could be controlled. Second, by beginning CPB immediately after sternotomy, we could achieve hemodynamic stabilization, thereby preventing overt rupture. After deploying the FET, trans-esophageal echocardiogram did not indicate blood flow into the TAA, and the patient’s hemodynamic status became stable even without CPB. We did not confirm that the distal landing length was adequate and that blood flow into the TAA was completely controlled, because it carried a risk of type 1B endoleak or retrograde false lumen blood flow. Thus, we carried out catheter aortography and performed additional TEVAR to obtain complete TAA exclusion. However, this technique

![Preoperative enhanced CT, large pericardial effusion (A), mediastinal hematoma, 60 mm of the TAA at the aortic arch and type B aortic dissection with patent false lumen in which the entry tear was located in distal site of the TAA (B). LCCA: left common carotid artery; LSCA: left subclavian artery](image1)

![The intraoperative aortography showed type 1B endoleak slightly and no retrograde false lumen flow (A: arrow). Endoleak disappeared after deployment of the stent graft (B).](image2)
had a risk of type 2 endoleak from the brachial artery or intercostal artery. And it is possible the blood flow into the aneurysm could not be controlled. In this case, enhanced CT after surgery did not show type 2 endoleak, and the aneurysm was well thrombosed. If the type 2 endoleak was detected, the additional intervention including embolization or open surgery with left thoracotomy should be considered.

We believe that the advantages of this technique are firstly, that type 1A endoleak cannot occur because the area proximal to the FET is anastomosed and secondly, additional TEVAR for distal extension is easily performed.

**Conclusion**

We employed the TAR and FET techniques with additional TEVAR for a ruptured TAA with type B aortic dissection, and the blood flow into the TAA was completely controlled. This hybrid technique may be a good option in similar cases.

**Disclosure Statement**

None declared.

**Author Contributions**

Study conception: YY  
Writing: YY  
Critical review and revision: all authors  
Final approval of the article: all authors  
Accountability for all aspects of the work: all authors

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