Aorto–Esophageal Fistula Caused by Distal Stent Graft-Induced New Entry after Frozen Elephant Trunk Technique for Chronic Aortic Dissection

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We present a case of aorto–esophageal fistula (AEF) caused by distal stent graft-induced new entry (dSINE) after the frozen elephant trunk (FET) technique for chronic aortic dissection. We propose that the combination of the spring-back force and the radial force of the FET may play a role in the occurrence of dSINE, leading to AEF. In this case, we successfully performed a three-stage surgery, including esophagectomy, descending aortic replacement, and esophageal reconstruction. To prevent this critical complication, additional endovascular aortic repair should be performed if the FET is not positioned at the straight portion of the descending aorta.

Keywords: frozen elephant trunk, aorto–esophageal fistula, chronic aortic dissection

Introduction

Total arch replacement (TAR) with the frozen elephant trunk (FET) technique simplifies the treatment of complicated thoracic aortic lesions; however, the usefulness of this technique for chronic aortic dissection (CAD) is unclear. Aorto–esophageal fistula (AEF) is a fatal condition that requires aggressive surgeries, such as esophagectomy, esophageal reconstruction, and graft replacement. Here we report a case of AEF caused by distal stent graft-induced new entry (dSINE) after the FET technique for CAD.

Case Report

A 79-year-old man underwent ascending aortic replacement (AAR) because of an acute type A aortic dissection. Two years after the AAR, enhanced computed tomography (CT) revealed residual aortic dissection with a patent false lumen. The diameter of the aortic arch and descending aorta was 60 mm and 50 mm, respectively. We thus performed a TAR with the FET technique (J Graft Open Stent Grafts®, Japan Lifeline Inc., Tokyo, Japan). The FET diameter was selected to be about 110%–120% of the true lumen diameter. This was calculated from the circumference of the true lumen at the level of the descending aorta and was designated as the distal landing position. We determined the insertion length of the FET according to the intraoperative measurement using transesophageal echocardiography that was set at the aortic valve level of the descending aorta, and we inserted 90 mm in this case.

Enhanced CT after the FET technique exhibited the expansion of the true lumen and thrombosis of the false lumen at the level of the aortic valve of the descending aorta (Fig. 1A). The FET was not positioned at the straight portion of the descending aorta.
portion of the descending aorta (Fig. 1B); however, and we performed CT every half year. Three years after the FET technique, he was admitted to our hospital due to back pain. Enhanced CT revealed a new intimal tear just distal to the FET and rupture of the false lumen of the descending aorta (Fig. 2A and 2B). We diagnosed the rupture of the false lumen caused by dSINE and performed an emergency thoracic endovascular aortic repair (TEVAR). One week after the TEVAR, he had a high fever, white blood cell count, and C-reactive protein (CRP) level. Enhanced CT showed good expansion of the stent graft but free air inside the false lumen (Fig. 3). Esophagoscopy revealed a fistula 40 cm from the incisor, and AEF was diagnosed. The administration of intravenous broad-spectrum antibiotics was commenced, and we performed an esophagectomy through the right thoracotomy. Two months after the esophagectomy, we performed descending aortic replacement using a rifampicin-soaked Dacron graft.

An intravenous antibiotic agent was administered for 20 days after the surgery, and oral antibiotics were administered until the CRP was < 0.2 mg/dL. The patient underwent esophageal reconstruction 2 months later, and his postoperative course was uneventful.

**Discussion**

We have previously reported the usefulness of the FET technique for acute aortic dissection; however, the usefulness of this technique for CAD is unclear. AEF is a relatively rare and usually a life-threatening condition. Some cases of AEF occur after TEVAR, and its incidence was reported to be 1.6%–1.9%. There are no reports of AEF occurring as a complication after the FET technique.

In this case, AEF occurred after the false lumen rupture induced by dSINE, 3 years after the FET technique for CAD. We propose that dSINE occurred for the following mentioned reasons. First, when we performed the FET technique, the distal position was determined without radiography. Thus, we could not deploy the FET exactly in the straight portion of the descending aorta, and the FET was positioned in the distal portion of the aortic arch. In fact, enhanced CT after FET technique revealed that the angle between distal end of the FET and descending aorta was 20°, and this confirmed that FET was not positioned in the straight portion of the descending aorta. When anchored at the aortic arch, the FET has a tendency to spring back to its initial straight status, and this spring-back force on the distal end of the FET may play a role in the occurrence of dSINE. In addition, spring-back force might be focused on the distal edge of the FET because proximal edge of the FET was anastomosed, and this could enhance the spring-back force.

Second, insertion length of the FET was one of the risk factors that elevated the chances of the occurrence of dSINE. Li et al. performed TEVAR for 579 patients with type B aortic dissection. They concluded that the risk factors for dSINE were stent grafts of ≤ 145 mm in length and TEVAR performed in the chronic phase. In this case, insertion length of the FET was 90 mm, and this is one of the causes of the occurrence of dSINE. Third, in the case of CAD, the FET deployed at the narrowed true lumen with a thickened intimal flap could not fully expand early after deployment. We had selected 10% oversizing graft in diameter that was calculated from the circumference of the true lumen at the presumed distal landing zone. Although the FET gradually expanded over the long term, the intimal flap could not withstand the radial force, and dSINE could occur. Given the combination of the spring-back force and the radial force of the FET, dSINE could easily occur, resulting in the rupture of the false lumen. We think that AEF could easily occur due to mechanical compression by a large amount of hematoma or inflammation of the resorbed hematoma. In this case, we successfully performed a three-stage surgery, including esophagectomy, descending aortic replacement, and esophageal reconstruction.

We believe that an additional TEVAR should have been
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performed to prevent the occurrence of dSINE as the FET was not positioned in the straight portion of the descending aorta in the present case.

There are few reports about the treatment of CAD with FET technique. Di Eusanio et al.\(^5\) have reported short- and mid-term results after treatment of CAD with FET technique using the E-vita Open and E-vita Open plus (Jotec Inc., Hechingen, Germany). They performed FET technique for CAD in 49 patients, and the hospital mortality was 10.2%, neurological morbidity was 6.1%, and spinal cord injury was 10.2%. They reported that there were no dSINE patients in mid-term. Comparing with our case, they inserted long length of the FET, and their distal position of the FET was at T8–9 in 52.2% and >T10 in 45.7%, and this must be a straight portion of the descending aorta. We conclude that it is important to deploy the stent graft at the straight portion of the aorta to prevent the occurrence of dSINE.

**Conclusion**

We experienced a rare case of AEF caused by dSINE after the FET technique for CAD. To prevent the occurrence of dSINE, causing false lumen rupture as in the present case, additional TEVAR should be performed when the FET is not positioned at the straight portion of the descending aorta. However, the costs increase if TEVAR is performed for all patients who undergo TAR with FET technique for CAD. This is an issue for future research to explore.

**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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