Stent graft perforation of a frozen elephant prosthesis: does design matter?

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Abstract

The frozen elephant procedure, as a hybrid method to treat aortic pathologies involving the aortic arch and the proximal descending aorta, has become an accepted treatment option. We report two late fractures of the nitinol stents of the endograft of an early frozen elephant trunk prosthesis. One patient suffered from a tear of the woven polyester fabric, causing a Type III endoleak and rapid progression of the existing descending aortic aneurysm. The patient received replacement of the descending aorta. The second patient showed a fracture of a nitinol stent without further complications during follow-up.

Keywords: Frozen elephant trunk • Thoracic aortic surgery • Type III endoleak

INTRODUCTION

The frozen elephant trunk (FET) technique has been established as a surgeon-driven innovation to treat aortic pathologies involving the aortic arch and the proximal descending aorta with a proximal non-stented part for aortic arch replacement and a stented part to be placed in the descending aorta [1, 2]. Patients receiving FET prostheses may suffer from late complications similar to those described in thoracic endovascular aortic repair (TEVAR) [3]. Currently, there are two prefabricated FET prostheses available: the Thoraflex hybrid graft (Vascutek, Terumo) and the E-VITA Jotec hybrid graft (JOTEC GmbH) [4, 5]. However, patients that were treated during the early phase of FET development have received custom-made grafts that may pose the risk of mechanical complications. Here we describe 2 cases of a nitinol stent fracture in patients after FET treatment.

CASE DESCRIPTION

Case 1

The patient suffered from an aortic dissection Stanford type A in 1991, and was treated with a mechanical valve conduit (Carbomedics 27 mm, Sorin, Milan, Italy).

In 2002, the patient underwent replacement of the aortic arch and the proximal descending aorta using a custom-made FET prosthesis (Curative Medical Devices GmbH, Dresden, Germany) due to progressive aortic arch and proximal descending aortic dilatation. In 2005, the patient needed reoperation due to an anastomotic aneurysm at the prosthesis-prosthesial anastomosis and the left coronary ostium. The patient received re-replacement of the ascending aorta and the aortic arch, leaving the stented graft in place with reconstruction of the left main coronary artery using a polytetrafluorethylene (PTFE) graft.

Late follow-up computed tomography angiogram showed a new Type III endoleak at the distal end of the stented graft resulting in a rapid progression of maximum diameters in the descending aorta (Fig. 1). We chose to openly replace the stent due to unavailability of a sufficient distal landing zone for TEVAR.

The operation was performed through a left thoracotomy with cannulation for extracorporeal circulation initiated via the groin. The FET prosthesis was clamped distal to the left sub-clavian artery, and the stented part was resected. The descending aorta was replaced up to the coeliac trunk, using a 30-mm polyester prosthesis (Gelweave, Vascutek, Renfrewshire, Scotland). Evaluation of the stented graft revealed a fracture of the nitinol stent, and a subsequent tear of the woven polyester fabric that had caused a Type III endoleak (Fig. 2). Postoperative course was uneventful with no major complications during 2-year follow-up.

Case 2

The patient was initially treated with an aortic valve reconstruction, proximal aortic arch repair and antegrade stent graft implantation into the descending aorta due to acute aortic dissection in 2007. In 2009, the patient received a mechanical valve conduit (25 mm ATS) and complete aortic arch repair using a custom-made FET prosthesis (Curative Medical Devices GmbH, Dresden,
Germany) due to degenerative aortic valve insufficiency and dilatation of the aortic arch and descending aorta. The aortic endograft was removed from the descending aorta. Owing to progressive dilatation of the downstream aorta, the patient underwent replacement of the thoraco-abdominal aorta.

During follow-up, a fracture of the nitinol stent of the FET prosthesis was diagnosed (Fig. 2C). However, neither an endoleak nor a dilatation of the stent graft or the aorta was noticeable at the time of imaging. The patient will undergo close follow-up imaging.

**DISCUSSION**

As an evolution of the classical elephant trunk, the ‘frozen elephant trunk technique’ has significant advantages as the distal landing site of the stent graft may be placed in a non-diseased portion of the descending aorta, covering its proximal portion [1, 2]. Patients receiving a FET require close follow-up imaging to identify complications. This is the first case report about a Type III endoleak after FET implantation due to a nitinol stent fracture. The diagnosis of a Type III endoleak can be difficult, and Type II endoleaks resulting from lumbar arteries need to be distinguished.

The FET technique is a great example for a technical innovation driven by multiple surgeons over more than a decade in a step-by-step fashion from ‘self-made’, ‘patient-specific custom-made’ to prefabricated ‘off the shelf’ solutions [1–3, 5]. Current grafts have overcome technical drawbacks of initial models. In particular, the nitinol stent structure has been significantly improved to control rigidity, retraction force and possible graft damage caused by friction between the stent structure and the polyester graft. The stent design plays an important role in avoiding mechanical complications. The use of relatively rigid interconnections between multiple z-shaped nitinol stent rows such as in the early FET graft described above, constitutes a risk for stent rupture and consequent endoleak. Both currently available FET grafts use non-connected rows of nitinol stents [2, 5]. In addition, the Thoraflex...
graft does have oval-shaped nitinol stents, and uses a multilayered design of one thin nitinol wire for each stent ring. Its retraction force is lower compared with that of Jotec graft that displays z-shaped one wire rows. This might further reduce mechanical complications after FET therapy. However, stent fractures have not been described for both grafts yet.

The introduction of the FET technique is a great achievement in aortic surgery. As with every new surgical device, surgeons have to be aware of possible specific complications seen in this relatively new technology. Similar to TEVAR therapy, patients treated with a FET should undergo close follow-up imaging.

**Conflict of interest:** Malakh Shrestha and Axel Haverich declare that they serve as consultants for Vascutek Terumo.

**REFERENCES**


