

CASE REPORT

Emergency Endovascular Repair of Symptomatic Post-dissection Thoraco-abdominal Aneurysm Using a Physician Modified Fenestrated Endograft During the Waiting Period for a Manufactured Endograft

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Introduction: Fenestrated branched endovascular aortic repair with custom manufactured devices (CMDs) has been applied to treat post-dissection thoraco-abdominal aortic aneurysms (TAAA), but the long waiting period for device manufacture limits its application in symptomatic or contained ruptured aneurysms.

Report: A 59 year old female presented with a 7 cm chronic post-dissection extent II TAAA. The patient underwent first stage total arch repair with the elephant trunk technique. At the time of the initial placement of the thoracic stent graft a fenestration was created in the septum to perfuse the right renal artery, which originated from the false lumen. A second stage procedure was planned with a CMD, but the patient presented with severe chest pain and lower extremity weakness, which was attributed to compression of the true lumen below the renal arteries due to increased flow into a pressurised false lumen. The patient underwent successful repair using a physician modified endograft (PMEG) with four fenestrations and preloaded guidewires. Follow up at 21 months showed no complications and a widely patent stent graft.

Discussion: The Zenith Alpha has several advantages over the TX2 platform for modification, notably lower profile fabric and wider Z tents, which provide greater flexibility for the creation of fenestrations or branches. In this case, the creation of a larger fenestration during the first stage procedure probably contributed to pressurisation of the false lumen. PMEGs remain a valuable option for TAAA repair, including chronic post-dissection aneurysms. Their application is particularly useful in symptomatic patients who are not candidates for an off the shelf endograft and cannot wait for a device to be manufactured.

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INTRODUCTION

Fenestrated branched endovascular aortic repair (F-BEVAR) has been used to treat chronic post-dissection thoraco-abdominal aortic aneurysms (TAAAs), most often with custom manufactured devices (CMDs).^{1–6} A CMD limitation is the long waiting time for device manufacture, which prevents its use in symptomatic patients who are otherwise unsuited to off the shelf options. The application of a physician modified endograft (PMEG) to treat a patient who

developed symptoms while waiting for a CMD to treat a chronic post-dissection TAAA is described.

CASE REPORT

A 59 year old woman presented with an enlarging 7 cm post-dissection extent II TAAA. The patient underwent total arch repair with an elephant trunk with a short segment thoracic endovascular aortic repair four months prior to presentation. Computed tomography angiography (CTA) demonstrated a re-entry at the level of the right renal artery (RRA), which was perfused by the false lumen. The left renal and mesenteric vessels were perfused by the true lumen (Fig. 1A and B).

The patient underwent extension of the thoracic endovascular repair to the level of the coeliac axis coupled with endovascular fenestration of the dissection septum to improve perfusion into the RRA. This was performed using intravascular ultrasound (IVUS) and a re-entry catheter to

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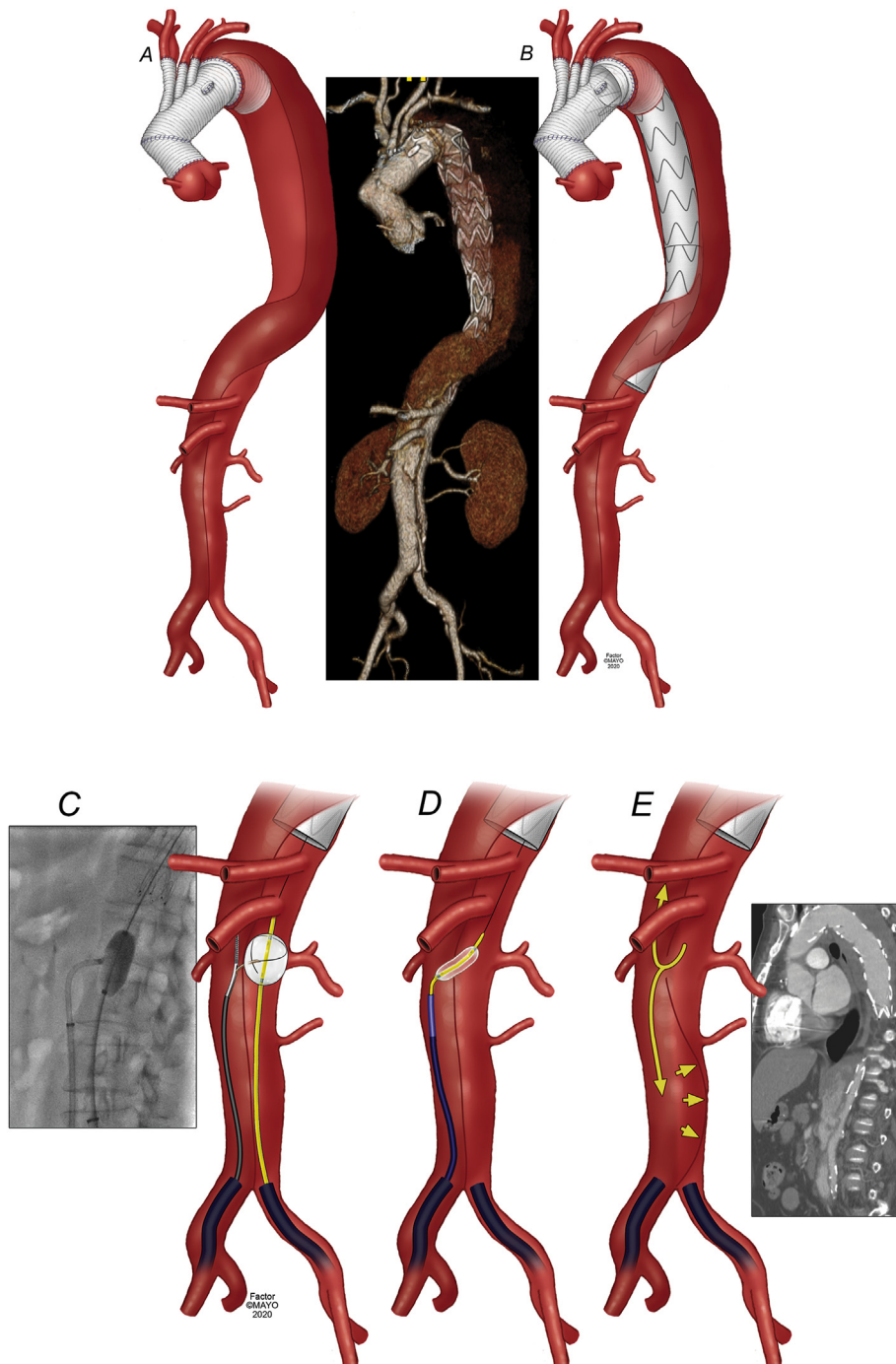


Figure 1. Colour illustration and three dimensional computed tomography angiography reconstruction of an extent II post-dissection thoraco-abdominal aortic aneurysm status post-total arch repair with elephant trunk. (A) Stage 1 repair with thoracic stent grafting from the elephant trunk to the level of the coeliac axis with two tapered Zenith Alpha endografts. (B) Illustration of balloon dilation of a small re-entry at the level of the right renal artery by inflating a Coda balloon in the true lumen, and using a re-entry catheter from the false lumen to puncture the septum and Coda balloon to establish wire access across the septum. (C) A Coda balloon was used to dilate the re-entry and facilitate future incorporation of the right renal artery. (D) Illustration of compression of the true lumen by a pressurised false lumen, below the level of the dilated re-entry. (E) Illustration of sequential catheterisation of the four target vessels from the upper extremity approach. (F) Illustration and three dimensional reconstruction of the completed four vessel fenestrated repair using (G) a physician modified Zenith Alpha thoracic stent graft

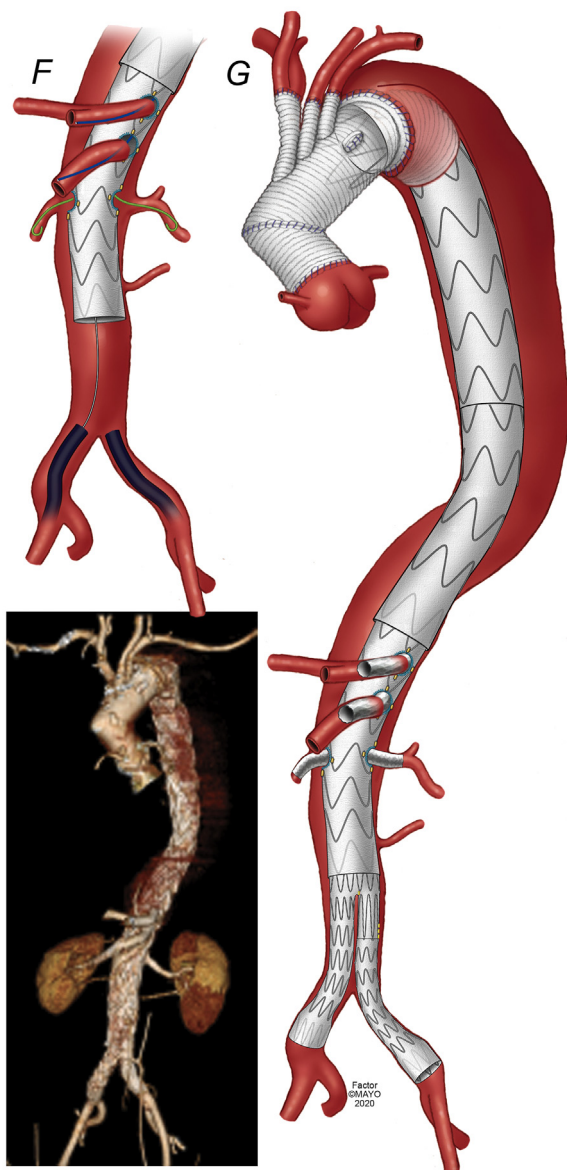


Figure 1. (continued)

access the false lumen, followed by balloon angioplasty with a partially inflated 32 mm Coda balloon (Fig. 1C and D). The patient was discharged home on post-operative day four, with no complications. A second stage procedure was planned with a CMD, but the patient returned two weeks later with severe chest pain and two separate episodes of bilateral lower extremity weakness. On examination, there were decreased lower extremity pulses. CTA revealed compression of the true lumen in the infrarenal aorta by the pressurised false lumen from the new fenestration (Fig. 1E). Retrospective review of the completion rotational angiogram after the first stage procedure demonstrated the same phenomenon (Video S1; see Supplementary Material).

Supplementary video related to this article can be found at <https://doi.org/10.1016/j.ejvsf.2020.08.003>.

The following are the supplementary data related to this article: Video S1 Rotational digital subtraction angiography demonstrating pressurisation of the false lumen causing compression of the true lumen, in an extent II post-dissection thoraco-abdominal aneurysm after balloon dilation of a re-entry in the septum.

Stent graft modification

A four vessel fenestrated repair was planned using a PMEG with a Zenith Alpha thoracic stent graft (Cook Medical, Bloomington, IN, USA) (Video S2; see Supplementary Material). The technique of graft modification has been described previously for the TX2 thoracic stent graft (Cook Medical). A tapered 36 × 32 × 209 mm Alpha stent graft was unsheathed from its original 18 F introducer sheath under strict sterile conditions. The barbs were removed from the proximal fixation stent. Using ophthalmological cautery, 6 × 6 mm fenestrations were created according the pre-operative measurements for the coeliac axis, superior mesenteric artery (SMA), and bilateral renal arteries. Each fenestration was reinforced with a double layer of nitinol wire, anastomosed with a running locking 5–0 Ethibond suture. Radiopaque gold markers were placed on each fenestration (12, 3, 6, and 9 o'clock) and at the 12 and 6 o'clock position of the device to facilitate intracorporeal device orientation. Diameter reducing ties were added to allow repositioning of the device. Four 0.014 inch guide-wires were preloaded into each fenestration and oriented for upper extremity access. The device was re-sheathed into the original delivery system, with a total modification time of 60 minutes.

Supplementary video related to this article can be found at <https://doi.org/10.1016/j.ejvsf.2020.08.003>.

The following are the supplementary data related to this article: Video S2 Video demonstrating the modification of a Zenith Alpha thoracic stent graft, with creation and reinforcement of four fenestrations for the coeliac axis, superior mesenteric artery, and bilateral renal arteries. Placement of anterior markers, posterior markers, double diameter reducing ties, preloaded wires oriented for upper extremity access, and device re-sheathing is also demonstrated.

Operative technique

Device implantation was performed under general endotracheal anaesthesia in a hybrid operating room using GE Discovery IGS 740 (GE Healthcare, Chicago, IL, USA). Measures to prevent spinal cord injury included cerebrospinal fluid drainage, permissive hypertension (mean arterial pressure ≥ 80 mmHg), intra-operative motor evoked and somatosensory evoked potential monitoring, near infrared spectroscopy, and early lower extremity reperfusion. Bilateral percutaneous femoral and left brachial surgical access were obtained. Through and through brachial left femoral access was established with a 0.035 inch, 480 cm Tracer metro Direct GuideWire (Cook Medical). IVUS was used to

confirm positioning in the true lumen. A 12 F Gore Dryseal Flex sheath (W.L. Gore, Flagstaff, AZ, USA) was advanced from the left brachial artery to the descending thoracic aorta and a 20 F Gore Dryseal sheath (W.L. Gore) was placed in the left common femoral artery. Using a 6 F × 110 cm sheath advanced from the 12 F brachial sheath and exteriorised via the left femoral access, a second through and through metro Direct wire was placed. The 6 F sheath was removed, re-introduced via one of the through and through wires, and again exteriorised via the femoral sheath, after which the through and through wire was removed. Once onlay fusion was calibrated, the device was oriented extracorporeally, loaded over the through and through metro Direct wire, while the four preloaded 0.014 inch guidewires were loaded through the 6 F sheath and retrieved via the left brachial access. The modified fenestrated stent graft was advanced, positioned using onlay fusion and deployed in a staggered fashion. Sequential catheterisation of the target was performed through the 12 F brachial sheath using a 6 F sheath via each preloaded wire. Once the sheath was within the fenestration, a buddy catheter was used for catheterisation of the target vessel. Amplatzer wires were placed in the coeliac axis, and SMA and Rosen wires in the renal arteries. The PMEG was completely deployed, the diameter reducing ties were removed, and the repair was extended distally with a bifurcated device and iliac limb extensions. The stent graft was dilated with a compliant balloon and flow was restored to both lower extremities by removing the large sheaths while maintaining haemostasis with percutaneous sutures. Sequential target vessel stenting was performed using iCAST balloon expandable covered stents (Atrium Maquet, Hudson, NH, USA). Completion cone beam computed tomography was performed with and without contrast and demonstrated a widely patent repair with no target vessel kink, compression, or endoleak. The patient had an uneventful post-operative course and was discharged home on hospital day 10, neurologically intact. Follow up at 21 months showed no endoleak and widely patent branches.

DISCUSSION

PMEGs can be useful in patients who cannot wait or are not suitable candidates for off the shelf endografts or patient specific CMDs. Because device manufacturing time ranges from four to 12 weeks, some patients may develop symptoms, rapid expansion, or rupture. In the case presented here, the acute symptoms probably resulted from sac pressurisation after creation of a large fenestration. Although there was initial concern that the renal artery was not adequately perfused, the fenestration should have been avoided and probably led to changes in flow dynamics and sac pressurisation. Whereas an off the shelf stent graft can be used in select cases, the devices can be limited by anatomical constraints such as variations in the four vessel anatomy and the upward orientation of the renal arteries.⁷ Bisdas et al. found that only 49% patients met strict

anatomical criteria for a four vessel multibranch stent graft, with an increase to 63% with adjuncts such as thoracic stent grafting or carotid–subclavian bypass.⁸ Among patients with chronic dissections, the compressed true lumen can pose a problem, although many experienced operators consider this only a relative limitation.

Prior to US Food and Drug Administration approval of the Zenith Alpha in September 2015, the authors used the Zenith TX2 platform.⁹ Some of the advantages of the Zenith Alpha include the lower profile introduction system, ranging from 16 F to 20 F, as well as larger stent cell, which provides more space for placement of fenestrations and branches, reducing the need to relocate stents.¹⁰ Prior to the availability of manufactured devices under a physician sponsored investigation device exemption (IDE) protocol (2007 and 2012), PMEG was the primary method used to treat complex endovascular repair in higher risk patients. Since then (2013 – present), PMEGs have been replaced by CMDs or off the shelf devices for nearly all cases, except for those who do not meet anatomical or clinical criteria for the IDE study.²

CONCLUSION

PMEGs remain a valuable option for TAAA repair, including chronic post-dissection aortic aneurysms. Application is particularly useful in symptomatic patients who are not candidates for off the shelf endografts and cannot wait for the manufacture of a CMD.

CONFLICTS OF INTEREST

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