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CASE REPORT

Fenestrated TEVAR combined with distal fEVAR for treatment of an extensive post-dissection thoracoabdominal aneurysm – a case report

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ABSTRACT

BACKGROUND: Proximal sealing in chronic post-type B dissection aneurysms usually requires a landing zone in zone 1 or 2 of Ishimaru. Classically, this has been addressed through hybrid surgery, which involves surgical cervical debranching and TEVAR. We present a case where a proximal fenestrated TEVAR was used for adequate proximal sealing.

CASE-REPORT: A 77-year-old male patient with a history of previous uncomplicated type B aortic dissection presented with a post-dissection extent II thoraco-abdominal aortic aneurysm. The maximum aortic diameter was 5.8cm, and all target vessels arose from the true lumen. To achieve an adequate proximal seal, we aimed to use Ishimaru zone 1 as a total seal and zone 2 as an effective seal. For the prevention of spinal cord ischemia, a staged repair was planned. In the first stage, a fenestrated TEVAR custom-made device was used, including a scallop for the innominate artery and left common carotid and a preloaded fenestration for the left subclavian artery, in addition to a distal tapered thoracic component reaching 5cm above the celiac trunk. In the second stage, a custom-made 4-fenestrated device was used in addition to a proximal bridging thoracic component and a distal custom-made bifurcated graft.

Both procedures were successful, with postoperative imaging confirming adequate exclusion of the aneurysm and preservation of visceral flow.

CONCLUSION: Custom-made device platforms allow a tailored approach for each patient. The fenestrated TEVAR technique enables proximal sealing in the mid-aortic arch, thereby avoiding the need for surgical cervical debranching.

Keywords: Thoracic Aortic Aneurysm; Aortic Dissection; Endovascular Procedures; Fenestrated Endovascular Aneurysm Repair; Custom-made device

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BACKGROUND

Proximal sealing in chronic post-type B dissection aneurysms usually requires a landing zone in zone 1 or 2 of Ishimaru. Classically, this has been dealt with hybrid surgery: surgical cervical debranching and TEVAR. We present a case where we used a proximal fenestrated TEVAR (f-TEVAR) for adequate proximal sealing. This procedure has expanded the possibilities of endovascular arch repair, allowing treatment of pathologies involving the aortic arch that require sealing in Ishimaru zones 1 and 2.

CASE-REPORT

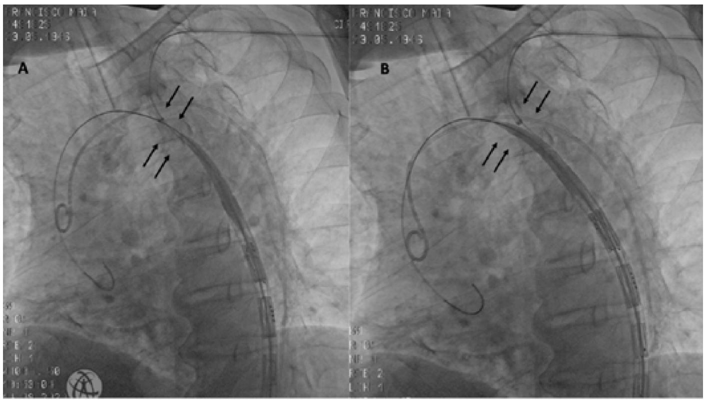
We present a case of a 77-year-old male patient with a history of hypertension, dyslipidemia, non-insulin-dependent diabetes mellitus, former smoker (in cessation since 2001), laparoscopic cholecystectomy, hemorrhagic stroke of the left hemisphere in 2018 with full recovery, and polycystic kidneys. In 2019, the patient developed an uncomplicated type B aortic dissection, managed conservatively with adequate anti-hypertensive control and imaging follow-up. During follow-up, there was a progressive dilation of the thoracic and abdominal aorta, degenerating into a type II thoraco-abdominal aortic aneurysm [TAAA] reaching a maximum aortic diameter of 5.8cm. All target vessels arose from the true lumen, and there were no signs of true lumen compression or organ malperfusion, Figure 1.

Figure 1. 3D computed tomography reconstruction of the post-dissection type II thoraco-abdominal aneurysm

Due to the growth rate and size of the aneurysm, the patient was proposed for staged aneurysm repair using complex endovascular treatment to prevent spinal cord ischemia (SCI). In the first stage, a fenestrated custom-made TEVAR was used, using a scallop for the innominate artery and left common carotid (20mm deep, 30mm wide) and a preloaded fenestration for the left subclavian artery, in addition to a distal tapered thoracic component landing 5cm above the celiac trunk. To achieve an adequate proximal seal, we aimed to use Ishimaru zone 1 as a total seal and zone 2 as an effective seal. The operation was performed in an operating room equipped with fusion guidance, and cardiac output reduction was planned. Surgical access of the left axillary and left femoral arteries and right percutaneous femoral access were obtained.

A wire was advanced to the ascending aorta, and serial angiographies at different aortic levels were performed to confirm true lumen positioning. The device was advanced over a Lunderquist® wire and parked initially at the descending thoracic aorta. A 320cm 0.035 floppy guidewire was then advanced through the preloaded catheter and snared in the descending thoracic aorta through the left axillary access to achieve a through-and-through wire. A 7 French hydrophilic sheath was then advanced through this wire from the axillary access and parked at the left subclavian artery ostium. Gentle traction was then applied to the through-and-through wire and the graft was advanced into the arch to correctly align the graft. During this manoeuvre, we observed entanglement of the through-and-through wire around the nose tip of the delivery system, so the device was brought back into the descending thoracic aorta The through-and-through wire was removed and re-snared, however, the issue of entanglement persisted. Therefore, while applying gentle traction to the through-and-through wire, the Lunderquist was pulled back to the inside of the device to completely disentangle the through-and-through wire around the delivery system. The Lunderquist was then carefully advanced in the aortic arch, Figure 2.

Figure 2. Intra-operative fluoroscopy images depicting technical aspects of f-TEVAR procedure.

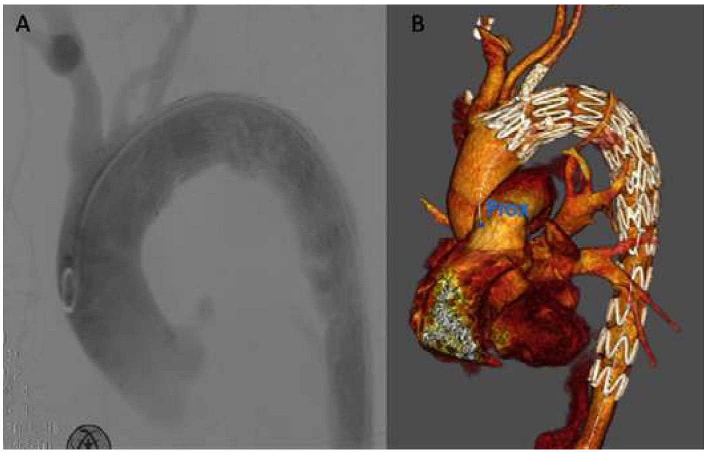


A) Entanglement of the through-and-through wire around the nose tip of the delivery system; **B)** Correct positioning of the through-and-through wire and delivery system

The endograft was then positioned while keeping tension on the through-and-through wire in order to align it with the fenestration in front of the target vessel, and its correct location was confirmed with angiography. The graft was then deployed under cardiac output reduction using the MuVIT technique.

To avoid squashing or dislocation of the bridging stent by the second thoracic endograft already planned, we decided to postpone the completion of the fenestration for last. After initial graft deployment (leaving the reducing ties), the fenestration for the left subclavian artery was catheterised through side puncture of the axillary sheath and placement of a Rosen wire in the ascending aorta. The through-and-through wire was removed, and the sheath was advanced through the fenestration, and the graft was then fully deployed. After the additional distal thoracic component (ZTA-PT-32-28-178) was deployed and the overlap was ballooned with a CODA balloon, the fenestration was stented using an Atrium Advanta stent (9x38mm), which was flared using a 12mm balloon. Final control angiography revealed patency of all supra-aortic trunks, no distal problems of the stent (kinks, stenosis, dissection) and no evidence of proximal endoleaks, Figure 3.

Figure 3. Completion images of the first procedure



A) Final control angiography at the level of the aortic arch; **B)** 3D computed tomography reconstruction after f-TEVAR

The postoperative period elapsed without any major complications or neurologic deficits. Follow-up CT scan showed optimal positioning of the prosthesis and bridging stent of the LSA.

In the second stage of treatment, a custom-made 4-fenestrated device was used in addition to a proximal bridging thoracic component and a distal custom-made bifurcated graft. A CSF drainage catheter was prophylactically placed before surgery. The surgery was performed via bilateral percutaneous femoral access. Access was achieved via ultrasound guidance and two Proglide Prostyle (Abbot) sutures were placed on each side (pre-close technique). Standard fenestrated technique was used with sequential catheterisation of the left renal artery (LRA), right renal artery (RRA), celiac trunk and superior mesenteric artery (SMA) without any complications associated with the procedures. For bridging stents, an Atrium Advanta 6x32mm was used for the LRA, a Bentley Begraft Peripheral 6x22 mm stent for the RRA, a Bentley Begraft Peripheral 10x27 mm stent for the celiac artery and a Bentley Begraft Peripheral 8x27mm stent for the SMA. A distal bifurcated custom-made device was then deployed in addition to bilateral iliac limbs (COOK ZSLE limbs). Final control angiography revealed patency of all vessels and a late type II endoleak, Figure 4.

Figure 4. Completion images after the second procedure

A) and **B)** Final control angiography at the visceral and infra-renal levels; C) Final 3D computed tomography reconstruction

Both femoral accesses were closed using the Proglides with no additional measures required. The overall procedure was successful, and postoperative recovery elapsed without any significant complications or neurologic deficits. The patient remained in the ICU for three days and was then transferred to the Vascular Surgery Department, being discharged after four days. The follow-up CT scan confirmed adequate exclusion of the aneurysm, preservation of visceral flow and no type I/III endoleaks. The patient is currently under a follow-up protocol and presents with a good clinical evolution.

DISCUSSION

There is a variety of aortic arch pathologies that require treatment, ranging from aneurysms, penetrating ulcers, to acute and chronic dissections.[1] Endovascular repair of the AA and aortic arch has evolved during the past decades, and it has begun to challenge the current gold standard status of open surgery in some groups of patients. Hybrid strategies with adjunctive cervical debranching for distal arch lesions are being replaced by fenestrated arch repairs. Total endovascular arch repair for proximal aortic arch pathologies, utilising inner branches, has achieved better results. However, the main current limitations of endovascular arch repair are diameter, length, and angulation-related issues with the AA (proximal landing zone).[2] In diseases with landing zones in the mid arch, by using a f-TEVAR approach one avoids having to deal with the AA, reducing some of these limitations.[3]

Cervical debranching followed by TEVAR is a well-established treatment for aortic arch lesions.[4] However, surgical debranching of the supra-aortic vessels presents various complications, including phrenic nerve injury, lymphatic leak, peripheral nerve injury, postoperative hematoma, the potential need for re-intervention and increased short-term mortality compared to endovascular aortic repair alone. To address these challenges, alternative strategies have been developed, such as branched or fenestrated TEVAR for the mid/distal arch. These approaches aim to reduce the risks associated with surgical debranching.[2,5]

Two main endograft designs for endovascular arch repair exist today: branched and fenestrated arch endografts. Branched endografts are typically used for proximal arch pathologies (zone 1 of Ishimaru), while fenestrated endografts are used in pathologies that require sealing in the mid-arch (zone 2 and 3 of Ishimaru). Depending on the selected device, fenestrated thoracic endografts can incorporate multiple fenestrations and can be combined with a proximal scallop. The potential target vessels of the fenestration ± scallop are the LSA and the LCA, or the LCA and the brachiocephalic trunk (after a carotid-subclavian bypass). Three complications are associated with deployment of a preloaded f-TEVAR: entanglement of the through-and-through guidewire around the delivery sheath or the main guidewire, entanglement with the proximal struts, and device malrotation. Due to the distance from the femoral arteries and the curvature of the arch, controlling the rotation of these devices is challenging. Precise deployment relies heavily on preoperative planning, the use of pre-curved delivery systems and pre-loaded catheters.[3]

Both techniques (branched TEVAR and f-TEVAR) showed excellent midterm patency rates for the target vessel and high technical success rate. The operation times were shorter in the f-TEVAR procedure and complications related to the debranching procedure were avoided such as higher morbidity and higher stroke rates.[4]

In conclusion, custom-made device platforms allow a tailored approach for each patient. f-TEVAR technique has expanded the possibilities of endovascular arch repair, allowing treatment of pathologies involving the aortic arch that require sealing in Ishimaru zones 1 and 2 avoiding surgical cervical debranching. The growing number of implantations has increased physician experience and helped identify critical procedural points, reducing the morbility and morbidity rates associated with this technique.

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