Physician-modified fenestrated Navion endograft for the treatment of a symptomatic postdissection thoracoabdominal aneurysm

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ABSTRACT

We report the case of a physician-modified four-fenestration endograft for the emergent treatment of a 65-year-old patient with postdissection thoracoabdominal aneurysm deemed unfit for open surgery. The patient, after elective thoracic endovascular aneurysm repair as the first stage of a preplanned two-stage total thoracoabdominal endovascular repair, presented acute onset of dyspnea and thoracic pain. Computed tomography angiography (CTA) showed signs of contained rupture. The Valiant Navion thoracic endograft was used for the creation of a physician-modified four-fenestration stent graft. A diameter-reducing wire technique was used to constrain posteriorly the prosthetic graft and to allow intraprocedural partial deployment. The modified stent graft was finally folded into its original sheath and implanted; four balloon-expandable stent grafts were used as bridging components. Postoperative CTA showed a residual type IIIc endoleak that was treated with a relining procedure 4 months later. At the 20-month follow-up, the patient is alive and well and CTA shows complete seal of the thoracic aneurysm with persisting small type IIIc endoleak in the abdominal aneurysm. A physician-modified endograft can be considered a valuable option in case of urgent treatment of TAAA in patients deemed unfit for open surgery when off-the-shelf devices are not available or contraindicated. (J Vasc Surg Cases and Innovative Techniques 2021;7:344-9.)

Keywords: Chronic dissection; Postdissection thoracoabdominal aortic aneurysm; TEVAR; Complex endografting; Physician-modified endograft

In the last decade, total endovascular management of postdissection thoracoabdominal aneurysm (pD-TAAA) has become a valuable alternative in patients unfit for open surgery with acceptable morbidity and mortality rates.[1] However, owing to visceral vessels origin variability, this procedure often requires custom-made devices (CMDs). The manufacturing time may preclude this option in urgent setting and true lumen (TL) narrowness in postdissection patients may exclude also the use of off-the-shelf devices in selective anatomic settings. We treated a symptomatic pD-TAAA with a physician-modified thoracic endograft (PMEG) and a new model of thoracic endograft.

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METHODS

A 65-year-old woman with severe pulmonary obstructive disease and ischemic heart disease was referred to our hospital with a 65-mm pD-TAAA. Twelve years earlier, the patient was treated for acute Stanford type B aortic dissection complicated by left renal malperfusion, with endovascular fenestration of the lamella at the level of left renal ostia and deployment of a bare metal stent into the left renal artery (LRA) and right common iliac artery.

Preoperative computed tomography angiography (CTA) is shown in Fig 1. After multidisciplinary discussion, patient was deemed unfit for open surgery owing to severe comorbidities. A two-stage treatment was planned: thoracic endovascular aneurysm repair plus celiac artery (CA) rerouting into the TL with a stent as a first stage, followed by a custom-made four fenestrations endograft, to decrease the risk of paraplegia.[2]

Owing to small access vessels and the presence of previous iliac stent, first stage was performed with two low-profile covered seal Valiant Navion endografts (proximal 37 × 31 × 207 mm, distal 34 × 28 × 207 mm; Medtronic, Santa Rosa, Calif) and deployment of a bare metal stent into the CA (7 × 15 mm; Vascular Express LD, Boston Scientific, Marlborough, Mass). One week later, the patient presented with thoracic pain and dyspnea. The CTA showed an 85-mm thoracic aneurysm contained rupture, pleural effusion, and left lung collapse (Fig 2). Rapid evolution of the aortic aneurysm and ongoing

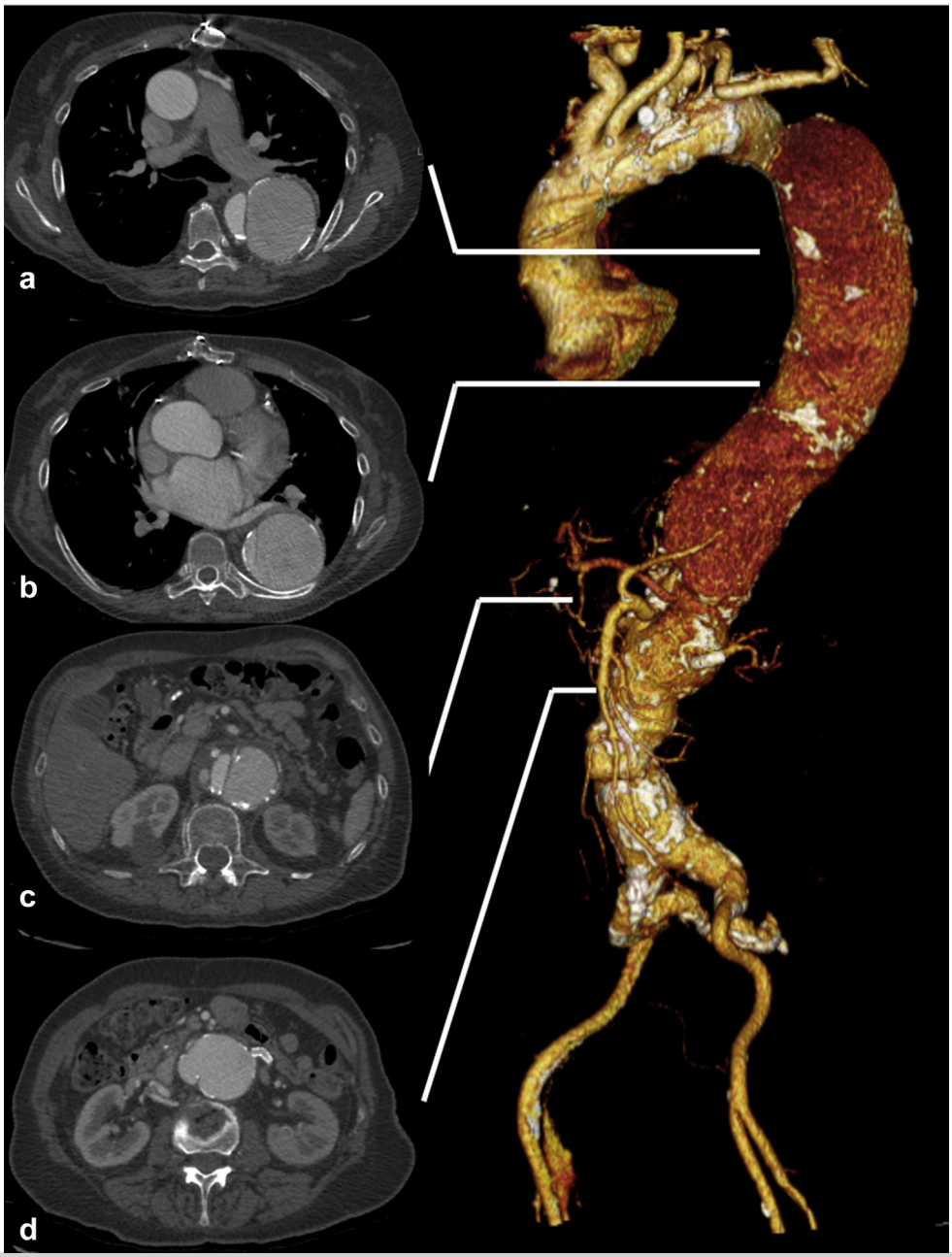

Fig 1. Preoperative computed tomography angiography (CTA) with volume rendering reconstructions (*right*) and axial views (*left*). **a,** A 65-mm maximum diameter postdissection thoracoabdominal aneurysm (pD-TAAA). **b,** Small entry tear at the level of the descending thoracic aorta (T8). **c,** Celiac artery (CA) partially originating from the false lumen and **(d)** large tear at the level of the renal arteries (RAs), left RA (LRA) originating from false lumen with previous artery stenting.

symptoms precluded waiting for the custom-made endograft production. The option of using an off-the-shelf branched endograft was excluded because of small TL diameter (9 × 20 mm) together with calcified walls just above CA origin. For this reason, a PMEG was planned We planned and designed a PMEG model immediately after CTA that was tested the day after on a 1:1 scale three-dimensional-printed aortic model. The three-dimensional model improved perception of distance and orientation of visceral vessels ostia and of the lamella interruption before the intervention.

Stent graft modification. Device modification was performed in hybrid operating theater (Video 1), equipped with a Allura Xper FD20 Angio system (Philips Healthcare, Best, the Netherlands). A 31-mm Valiant Navion

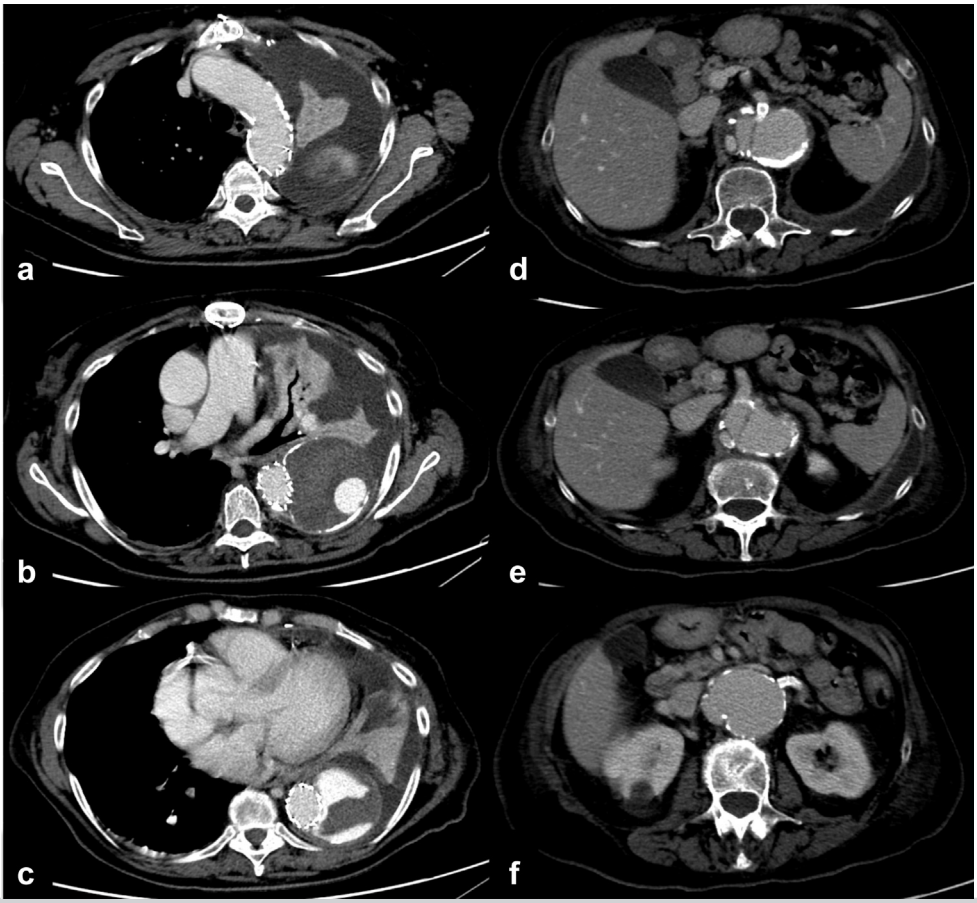

Fig 2. Axial views of thoracic aneurysm contained rupture with **(a)** complete left lung collapse, **(b)** a 20-mm sac enlargement and pleural effusion, false lumen perfusion at the level of **(c)** the distal descending thoracic aorta, **(d)** celiac artery (CA), **(e)** superior mesenteric artery (SMA), and **(f)** renal arteries (RAs).

stent graft was completely unsheathed without releasing the proximal bare stent, kept closed by the constraining mechanism of the Navion device; four fenestrations (8 mm for both the CA and superior mesenteric artery [SMA] and 6 mm for the renal arteries [RAs]) were made on the fabric with a thermo-cutter and reinforced with radiopaque gold-plated tungsten loop of a 7mm diameter Amplatz GooseNeck snare (Medtronic) as a marker and Ethibond (Ethicon) 4-0 running suture. A diameter-reducing wire was created using a 0.018″ guidewire (V18, Boston Scientific). The guide was inserted under the graft cover, pierced with a 16G needle upstream of the front grip. The guide was routed along the 6 o'clock mark, passing it between the stent and the polyester at the level of all the stents except the support stent below the free-flo. A total of two stent peaks or four stent struts were constrained at a time to avoid infolding of the stent graft. Two nonlocking 4-0 Prolene loops were used for each stent. This allowed the 31-mm Valiant Navion stent graft to be decreased to a diameter of 20 mm in the constrained form.

The modified stent graft was finally folded again into its original sheath using vessel loops (Fig 3).

Procedure. Under general anesthesia and after cerebrospinal fluid drainage catheter insertion, the femoral arteries were surgically exposed. Constrained graft was deployed under fluoroscopy with a 5-cm overlap in previously implanted thoracic graft. Diameter-reducing wire allowed partial deployment of the graft at two-thirds of its nominal diameter and facilitated PMEG rotation and alignment in the narrow TL. Moreover, fixation points of the posterior wall of the endograft to the guidewire limited the risk of graft twisting. Catheterization of SMA and right RA fenestrations were achieved using a 6.5F Destino Twist steerable catheter (Oscor Europe, Dusseldorf, Germany) with an Amplatz stiff (Cook Medical, Bloomington, Ind) and a Rosen (Infiniti Medical, Palo Alto, Calif) guidewire, respectively. The graft was then fully released at its nominal diameter by retracting the 0.018″ diameter-reducing wire. PMEG was then molded with a

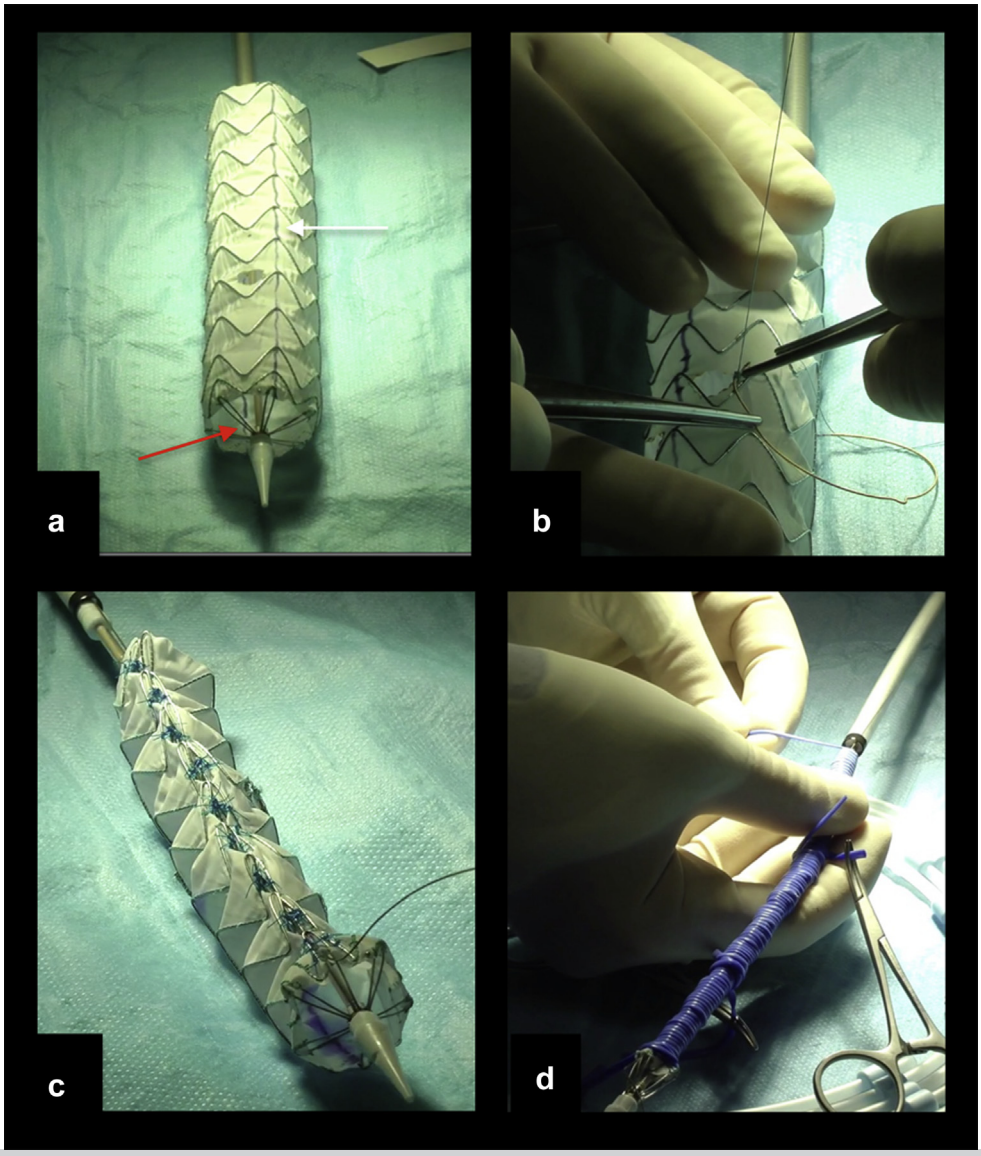

Fig 3. a, A stent graft was completely deployed without releasing the proximal bare stent, kept closed by the constraining mechanism of the Navion device (*red arrow*). A line was drawn using a sterile marking pen identifying the 12:00 o'clock (*white arrow*) and the planned position of each fenestration was measured and marked. **b,** Fenestrations were made on the fabric with a thermo-cutter and reinforced with a gold-plated loop as a marker and Ethibond 4-0 running suture. **c,** A diameter-reducing wire was routed along the 6 o'clock line marked; two nonlocking 4-0 Prolene loops were used for each stent to constrain the prosthetic graft at two-thirds of its original diameter, therefore creating a partial deployment system. **d,** The modified stent graft was finally folded again into its original sheath using vessel loops.

compliant balloon (Reliant, Medtronic) at the proximal overlapping region and at the visceral vessels fenestrations, because the TL narrowness at that level made bridging stents deployment challenging. The CA and LRA were then catheterized with the 6.5F Destino Twist steerable catheter. Target visceral vessels identification was enhanced by the presence of the previously placed stents that represented the selected landing zones. Four covered balloon-expandable bridging stents (BeGraft, Bentley, Hechingen, Germany) were delivered and flared in CA (BGP2707_02), SMA (BGP2307_02), right RA (BGP2206_02), and LRA (BGP5707_02). Distal sealing in the abdominal aorta was achieved by deploying a 37 × 90 mm Valiant Navion. Completion angiography showed visceral vessels patency and a residual small blush of contrast of uncertain origin at the level of fenestrations. Total procedure time was 400 minutes (100 minutes for stent graft modification),

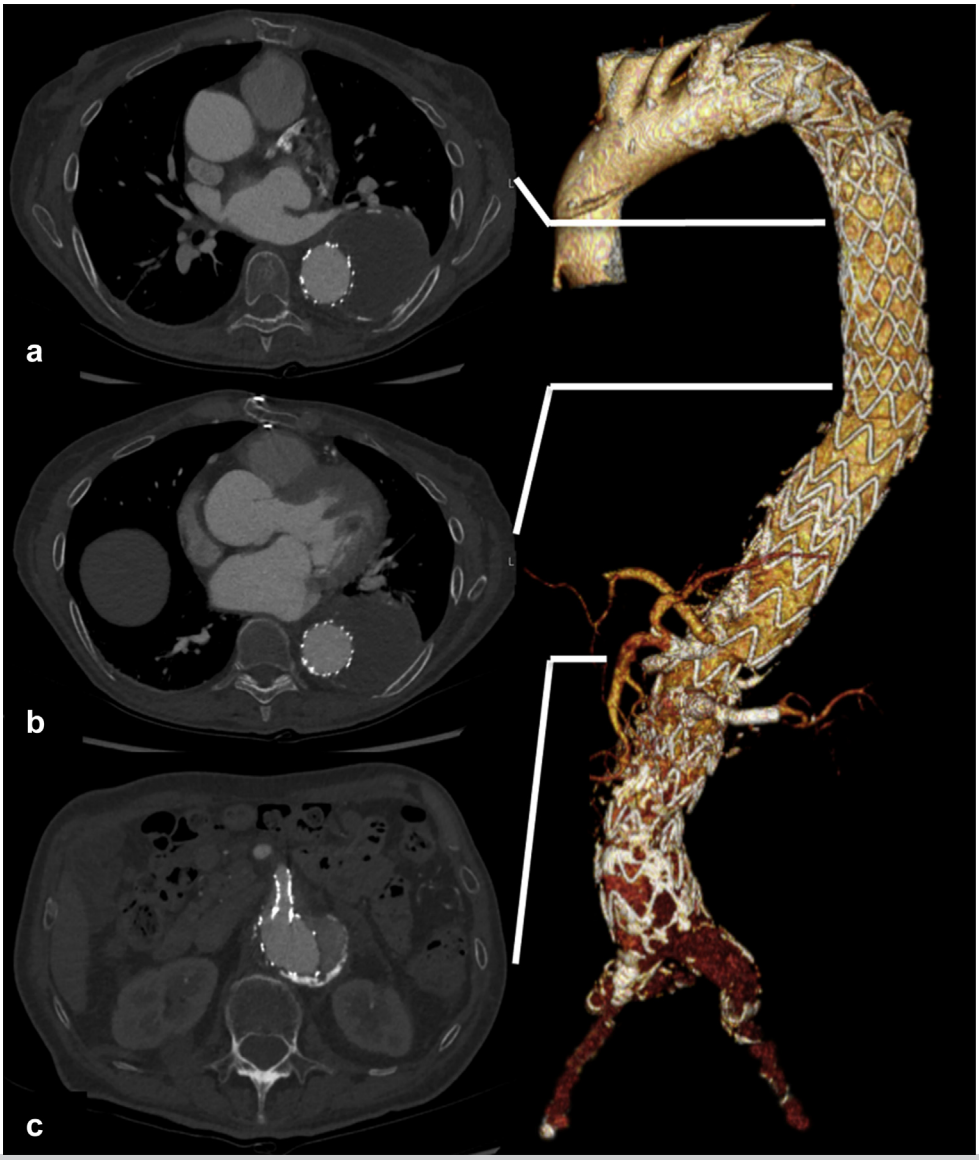

Fig 4. An 8-month computed tomography angiography (CTA) image with volume rendering reconstructions (*right*) and axial views (*left*). **a** and **b,** Complete thoracic false lumen thrombosis and **(c)** type IIIc endoleak at the level of the superior mesenteric artery (SMA).

fluoroscopy time was 70 minutes, and contrast volume was 150 mL.

The intensive care unit stay was 4 days, with immediate complete pain regression and no neurologic complications; hospitalization was uneventful. The patient was discharged on dual antiplatelet therapy.

Follow-up. Predischarge CTA revealed a type IIIc endoleak at the level of the SMA fenestration-bridging stent. Relining was performed 4 months after first treatment through a right percutaneous femoral access, selective vessel catheterization, and balloon-expandable stent deployment (BeGraft, Bentley, BGP2709_02). A small residual type IIIc endoleak remained visible, with complete thrombosis of the thoracic portion of the aneurysm and without sac enlargement (Fig 4). Considering patient's frailty and aneurysm diameter stability, no further treatments were planned. The patient is alive and well at 20 months.

DISCUSSION

Total endovascular treatment of pD-TAAA in patients deemed unfit for open repair represents a well-accepted approach with encouraging early and midterm results.[3] Usually staged procedures are required, with thoracic endovascular aneurysm repair first and fenestrated or branched endografting as second step to decrease the risk of spinal cord ischemia. In our case, occlusion of the proximal entry of the dissection probably caused increased pressurization of the false lumen,

creating a "single entry channel" with the wide lamella interruption at the level of the renal ostia.[4]

Symptomatic pD-TAAA treatment represents an adjunctive challenge compared with the atherosclerotic TAAAs owing to fragility of the aortic wall, narrowness of the TL, and possible extension of the dissection into visceral and iliac vessels. In these cases, open surgery represents the first option in suitable patients avoiding lengthy manufacturing time of CMDs in case of contraindication for use off-the-shelf branched endografts.[5]

PMEG has been proposed as an alternative approach in urgent atherosclerotic TAAAs for patients unfit for open surgery.[6] A systematic review by Georgiadis et al comparing 308 patients treated with PMEG or CMDs reported technical success of 91.4% and 95.0%, mortality rates of 3.2% and 0%, major adverse event rate of 12.8% and 7.4%, and target vessel patencies of 98% and 97%, respectively.[7]

In the present case, graft manufacturing was performed according to what reported by Oderich et al, who recently published a similar case of symptomatic pD-TAAA treated with PMEG with an alternative thoracic endograft model.[8,9] We preferred to use the Valiant Navion graft for its smaller crossing profile (it needed to traverse the previously placed and narrow iliac stent graft in a tortuous anatomy), the easy-to-maintain preexisting proximal constraining method of the top end of the device, and the absence of hooks or pins hard to handle when resheathing is needed.[10] The case was treated before the report of late structural failures of the Navion thoracic graft that suggested manufacturer voluntary recall of the product.[11] Obviously, the time spent to manufacture the graft should be taken into account; that time is about 1.5 hours, and it may be dangerous to wait in case of hemodynamically unstable patients.

The diameter-reducing wire technique, which allows an intraprocedural partial deployment of the graft, was for us crucial in this case of pD-TAAA with narrow TL because it facilitates the correct graft orientation and target vessel cannulation.[12]

BeGrafts have been chosen as bridging stent grafts for their low profile and the wide range of available lengths.[13] Residual type IIIc endoleak, decreased after first relining and then left untreated, may have occurred because fenestrations had been designed too large to decrease the risk of misalignment and failure to cannulate, but insufficient flaring of the mating stent graft was then not able to cope with the gap between the aortic and the visceral components. The procedure was, however, successful in promoting a false lumen thrombosis in the thoracic portion of the fissured TAAA, with a successful clinical result. According to literature, the presence of type IIIc endoleak should be considered a technical failure owing to possible late rupture secondary to sac pressurization.

CONCLUSIONS

PMEG can be considered a valuable option in case of urgent treatment of pD-TAAA in patients deemed unfit for open surgery, in case of unfavorable anatomies or unavailability of off-the-shelf devices. Navion endograft seems to present favorable characteristics to be physician-modified according to this single case experience.

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