Endoconversion During b-EVAR for Pararenal Abdominal Aortic Aneurysm

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Adverse events associated with stent-grafts during complex aortic procedures are rare but can be difficult to manage. These occurrences can be reduced by precise planning and anticipating complications by considering the patient's anatomy and the characteristics of the graft. This paper describes an endovascular conversion following branched endovascular aneurysm repair (b-EVAR) for a pararenal abdominal aortic aneurysm (pAAA) caused by the distal displacement of the stent-graft during delivery system retrieval. A replanned endovascular strategy (endoconversion) was performed by the deployment of another b-EVAR as a bailout technique. Technical success was obtained and the post-operative course and follow-up was uneventful. High technical skills with the ability to predict and manage complications can play a crucial role in the management of intraoperative adverse events.

Keywords: branched-EVAR; complex abdominal aortic aneurysm; adverse event; branched-EVAR complications; case report

Introduction

Complex endovascular aortic procedures for the treatment of abdominal and thoraco-abdominal aortic diseases have become common interventions during the last decades especially in unfit for surgery patients [1,2]. Custom-made or off-the-shelf (OTS) stent-grafts with fenestrations or branches were developed to treat complex aortic scenarios.

There are limited data describing unexpected complications related to stent-graft deployment and delivery system retrieval. This report presents an endovascular conversion following branched endovascular aneurysm repair (b-EVAR) for the exclusion of a pararenal abdominal aortic aneurysm (pAAA), due to distal displacement of the stent-graft during retrieval of the delivery system.

Case Report

A 64-year-old gentleman was admitted at our institution for an uncomplicated pAAA. The patient was an active smoker, affected by hypertension and dyslipidemia with previous multiple percutaneous coronary interventions for coronary artery disease. A clinical assessment by cardiologist and anaesthesiologist was performed and the patients was deemed unfit for open aortic repair.

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A contrast-enhanced computed tomography (CT) scan was performed at the admission and revealed the presence of a pAAA with the largest aortic diameter of 67 mm and a bilateral iliac aneurysm (maximum diameter right iliac 38 mm, left iliac 30 mm) with the chronic occlusion of left internal iliac artery. Both iliac axes and infrarenal aorta were affected by angulation and tortuosity. The access sites diameter were suitable for complex EVAR devices (fenestrated/branched).

A preoperative planning was performed with a dedicated software (Aquarius iNtuition, Terarecon Inc., San Matteo, CA, USA) and an OTS b-EVAR treatment was chosen. The selected device was the COLT stent-graft (3618156, Jotec GmbH, Hechingen, Germany) and was preferred for the characteristics of the side-branches (Fig. 1) that were downwarded and closer to the main body [3]. Moreover, the branches outlets were positioned in the tapered portion of the body and COLT stent-graft might guarantee a shorter total aortic coverage if compared with other available OTS b-EVAR (t-Branch, Cook Medical, Bloomington, IN, USA).

The writing of this manuscript adhered to the CARE (Case Report) guidelines and CARE checklist is available in the **Supplementary Material**.

A two-step procedure was planned in order to reduce the risk of spinal cord ischemia (extended aortic coverage, obstruction of left internal iliac artery). An informed consent was signed by the patient and data were treated accordingly to the National Policy in the matter of anonymized data. Ethics approval was waived due to the retrospective nature of the study with the aim to analyze techniques adopted during the standard practice. Both surgical procedures were performed under general anesthesia in a hybrid

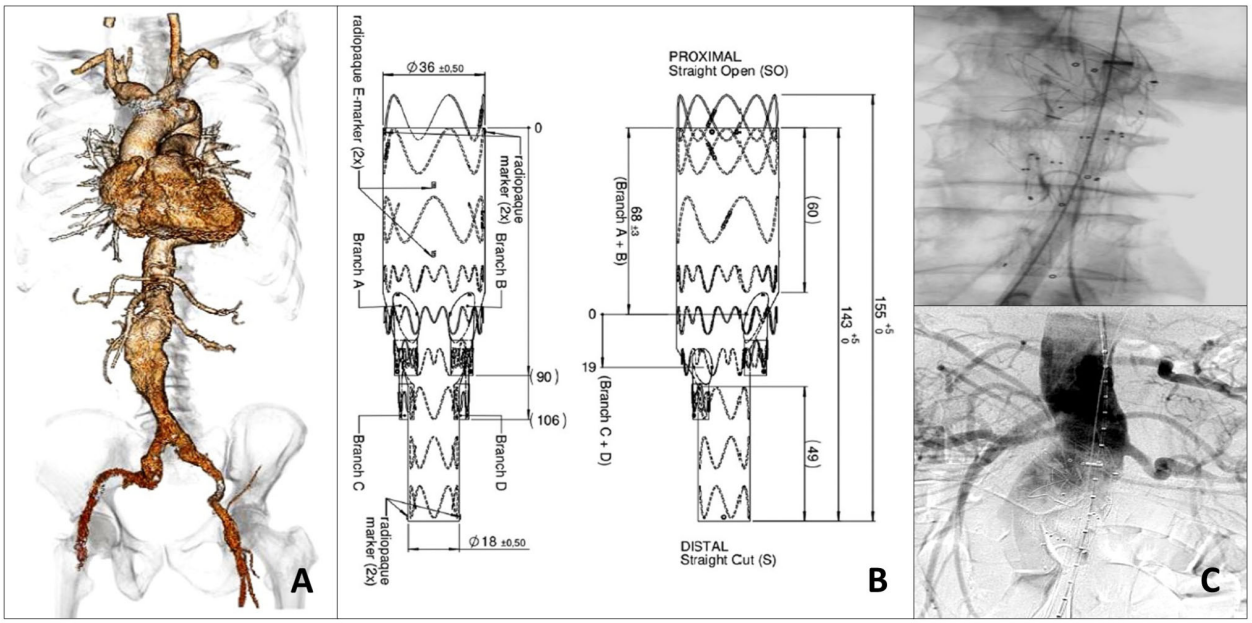

Fig. 1. Preoperative assessment and device selection. (A) Preoperative computed tomography scan angiography (Volume Rendering) showing pararenal abdominal aortic aneurysm and tortuous iliac axes. (B) Jotec COLT stent-graft, sizing sheet in frontal (left) and lateral (right) view. (C) Intraoperative crushing of the COLT stent-graft in the infrarenal aorta (upper) and angiography showing target visceral vessels patency.

room equipped with an Artis Zee ceiling-mounted angiography system (Siemens AG, Forchheim, Germany). A bilateral percutaneous femoral access was used to deploy the graft. Bilateral percutaneous femoral access was used in the first step and left brachial cut-down was performed for the second surgical stage.

The COLT stent-graft was delivered through the right femoral artery and deployed on fusion-CT guidance with the C-D renal side-branches at the level of the superior mesenteric artery (SMA) ostium. After the completion of the device deployment, the delivery system (DS) tip was pulled away into the DS sheath. During this manoeuvre, the tip captured the fabric of the stent-graft in the distal portion as a consequence of the tortuous aortic anatomy and of the reduced patent aortic lumen. The retrieval of the stent-graft DS caused a distal migration of the entire graft down to the level of the renal artery origins with the complete crushing of the device in the infrarenal aorta (Fig. 1C).

A bailout endovascular solution was then re-planned and a t-Branch stent-graft (Cook Medical, Bloomington, IN, USA) was deployed. A 10-mm balloon angioplasty was performed to re-create an adequate intra-prosthetic channel where the device was delivered at the suprarenal aorta crossing the COLT collapsed stent-graft. The t-Branch was deployed with the renal side-branches at the level of the SMA ostium. The delivery system was retrieved and the procedure was completed by an anatomical reconstruction of the aortic bifurcation with AFX stent-graft. A right covered endovascular reconstruction of iliac artery (CERIB) technique was performed for the preservation of the right hypogastric artery [4].

The post-operative course was uneventful and after 20 days the second step procedure was performed connecting the target visceral vessels (TVVs) to the graft. Between the two surgical steps, an angio-CT scan was performed in order to assess the residual aortic lumen for TVVs connections. The patient started temporarily single antiplatelet medication and anticoagulant therapy with low-molecular-weight heparin until the second procedural stage. This waiting period might mitigate the risk of spinal cord ischemia. TVVs were bridged using covered balloon-expandable stents. This strategy was preferred over self-expandable stents for the exiguous residual aortic lumen and the favourable anatomical characteristics of TVVs. The second endovascular stage were conducted under general anesthesia with the placement of a cerebrospinal fluid drainage.

The patient was discharged after 5 days from the second surgical procedure (In-hospital length of stay 22 days) and started a dual antiplatelet therapy medication for at least 60 days. The one-year follow-up CT scan showed patency of the stent-grafts without signs of endoleaks (Fig. 2). At five years from the intervention the patient is alive with active duplex ultrasound surveillance [3].

Discussion

Stent-graft related adverse events during complex endovascular aortic procedures are serious complications that can result in life-threatening such as aneurysm rupture or aortic wall lesions. The safety of complex aortic procedures was recently investigated by a large experience that demonstrated how f/b-EVAR procedures can be performed safely with good outcomes despite increasing in extent and

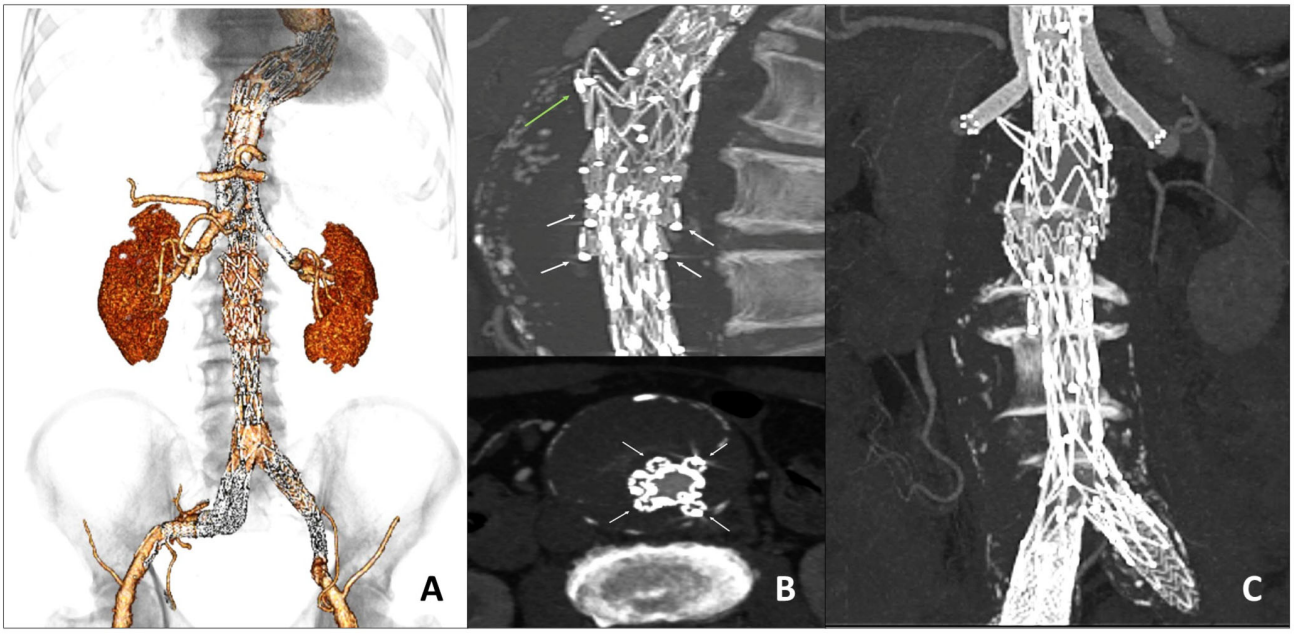

Fig. 2. Follow-up imaging suirvellance. (A) Post-operative computed tomography (CT) scan angiography (Volume Rendering). (B) Crushed stent-graft details, displaced COLT side-branches (white arrows), top bare metal stent (green arrow). (C) Maximum intensity projection (MIP) post-operative CT scan angiography showing the crushed COLT stent-graft in the infrarenal aorta.

complexity [5]. OTS b-EVARs were widely evaluated in the treatment of Thoraco-Abdominal Aortic Aneurysms (TAAAs) and their role in the treatment of juxta-pararenal abdominal aortic aneurysms (j-pAAAs) were studied as well. A recent experience showed the feasibility and effectiveness of OTS inner-b-EVAR in j-pAAA in a multicentric experience. Low rates of target vessels instability and high technical success were observed, although the increased aortic coverage might be associated with higher risk of spinal cord ischemia especially in patients with occluded hypogastric arteries and significant thoracic and paravisceral aortic thrombus [6]. A pooled analysis comparing side- and inner-branched OTS devices in a recent review stated that both techniques had good technical success and mortality rates even in urgent procedures but OTS iBEVARs needed further investigations to draw additional data owing to the small sample size [7].

The reported experience may be considered as a technical failure related to stent-graft migration as a plan-based fashion. However, an endovascular bailout strategy allowed technical and clinical success at the end of the intervention and during the post-operative surveillance.

Several hypotheses have been taken into account to explain the stent-graft migration. The stent-graft was delivered through the right iliac axis in the abdominal aorta without the assistance of an introducer sheath. This aspect might be associated with worse ability to control the torsional forces resulting from the tortuosity of the iliac axis and as a consequence the DS sheath was blocked in its position at the distal edge of the stent-graft. During the tip recapture manoeuvre, the fabric of the distal edge of the stent-graft was caught on the delivery system, and this event was poorly visible under fluoroscopy guidance. Another explanation lays in the slight angulation of the infrarenal abdominal aorta combined with a reduced patent aortic lumen. The tortuous anatomy combined with the absence of an introducer sheath may have caused the graft migration forcing the fabric into the DS sheath during the tip recapture manoeuvre. This aspect might be considered responsible for the displacement complication. As far as possible, the placement of an introducer sheath should always be performed, especially in challenging anatomies. Adverse events during complex aortic procedures related to stent-graft deployment might be mitigated by maintaining extreme accuracy throughout preoperative planning. The choice of the stent-graft should be evaluated considering several anatomical aspects in terms of lesion extent, patent aortic lumen, target vessels characteristics as well as access site anatomy and iliac axes tortuosity and diameters. An accurate planning might simulate, with a low but not-negligible error, the position of the stent-graft along the aortic segment, helping to anticipate potential issues related to vessel characteristics and stent-graft deployment.

Surgical and/or endovascular bailout strategies should be planned when performing complex aortic procedures to minimize and to manage potential complications. In our experience, the t-Branch stent-graft was primarily excluded because of the aortic and lesion anatomy. However, it represented the bail-out strategy to perform the procedure based on the clinical scenario.

Nowadays, new custom made graft designs are available on the market addressing different aortic scenarios including aortic lesions characterized by a narrow patent lumen (<25 mm), minimizing the aortic coverage [8].

Conclusions

Endoconversion during a b-EVAR procedure represents an uncommon situation in complex aortic procedures. The preprocedural planning may play a critical role in hostile accesses and tortuous anatomies focusing on predictable issues during the intervention. High technical skills, along with the ability to anticipate and manage complications, are essential in handling intraoperative adverse events.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

Writing the article: SZ, DA. Conception and design: SZ, DA. Analysis and interpretation: SZ, MC, AC, EG, LDS. Critical revision of the article: SZ, MC, AC, EG, LDS, DA. Final approval of the article: SZ, MC, AC, EG, LDS, DA. Overall responsibility: SZ, MC, AC, EG, LDS, DA.

Ethics Approval and Consent to Participate

Ethics approval was waived due to the retrospective nature of the study with the aim to analyze techniques adopted during the standard practice. This case report was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and all efforts have been made to ensure the anonymity and confidentiality of the patient's information. An informed consent was signed by the patient and data were treated accordingly to the National Policy in the matter of anonymized data.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://www.annaliitalianidichirurgia.it/journal/AIC/article/path/pii/S0003-469X(25)00059-0.

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