Endovascular Retrieval of Disconnected Tip From an Iliac Branch Device Stent Graft: A Case Report

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Ilaria Calicchio[1], Antonia Rinaldi[1], Nicola Cantile[1], Michele Vollono[1], Luca Del Guercio[1], Umberto Marcello Bracale[1], Davide Turchino[1]

[1]Vascular Surgery Unit, Department of Public Health, University Federico II of Naples, 80138 Naples, Italy

Endovascular repair of aneurysmal pathology in the aorto-iliac district presents one of the significant challenges in contemporary vascular surgery. Advances in techniques, materials, and devices have enhanced the ability of vascular surgeons in endovascular procedures, leading to the management of increasingly complex cases, with applications sometimes extending beyond the Instructions for Use (IFUs) of specific devices. In our case report, we describe the successful endovascular retrieval of a disconnected tip from an iliac branch device (IBD), preventing conversion to open surgery in a 73-year-old patient with a complex aortoiliac aneurysm. The case highlights the importance of exercising caution when treating patients with complex anatomy not in conformance with a device's IFU, even in high-volume centers with extensive endovascular expertise.

Keywords: intravascular foreign bodies; iliac branch device; endovascular retrieval; Instructions for Use; case report

Introduction

Endovascular repair has become the preferred treatment modality for abdominal aortic aneurysms (AAAs), proving lower early mortality rates when compared to open repair (OR) [1]. As such, endovascular repair is the first-line option for isolated iliac artery aneurysms (IIAAs), ensuring excellent short- and mid-term outcomes [2,3]. This minimally invasive approach is associated with high technical success rates, reduced mortality, and shorter hospital stays compared to traditional surgery [4]. With the continuous advancement of devices, techniques, and operator expertise, more patients are being treated with surgical devices that are employed by surgeons beyond the scope of their recommended Instructions for Use (IFUs), achieving optimal results [5,6].

As the frequency of endovascular procedures increases, so does the incidence of complications, such as endoleaks, branch occlusion, stenosis [7], and, in a minority of cases, dislodgement and potential embolization of foreign bodies [8,9], which is the focus of our case presentation.

Case Presentation

Patient information: A 73-year-old male patient was admitted to our General Surgery Department for elective repair of right inguinal hernia. His medical history was notable for hypertension, chronic ischemic heart disease, prior percutaneous transluminal coronary angioplasty (PTCA)/stenting, depressive syndrome, benign prostatic hyperplasia, chronic renal failure, multiple myeloma undergoing chemotherapy and vertebral collapse treated with stabilization surgery.

Diagnostic assessment: During a preoperative abdominal ultrasound examination, an asymptomatic large right aortoiliac aneurysm was discovered, prompting vascular surgery consultation with a further computed tomography (CT) angiography. The imaging confirmed the presence of a subrenal aortic aneurysm (maximum diameter: 43 mm) and a saccular aneurysm of the right common iliac artery (maximum diameter: 44 mm) (Fig. 1). Detailed anatomical features of the aneurysm are summarized in Table 1.

Treatment interventions: According to the 2024 ESVS Guidelines for the management of abdominal aorto-iliac artery aneurysms, elective repair is recommended when iliac artery aneurysms exceed 40 mm in diameter [10].

Table 1. Aneurysm's anatomical features.

	Diameters (mm)	Lengths (mm)	β angle
Abdominal aortic aneurism' neck	25	15	68°
Abdominal aortic aneurism	43	105	-
Aortic bifurcation	22	-	-
Right common iliac artery	44	70	-
Iliac bifurcation	14	-	-

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Correspondence to: Davide Turchino, Vascular Surgery Unit, Department of Public Health, University Federico II of Naples, 80138 Naples, Italy (e-mail: dott.turchino@gmail.com).

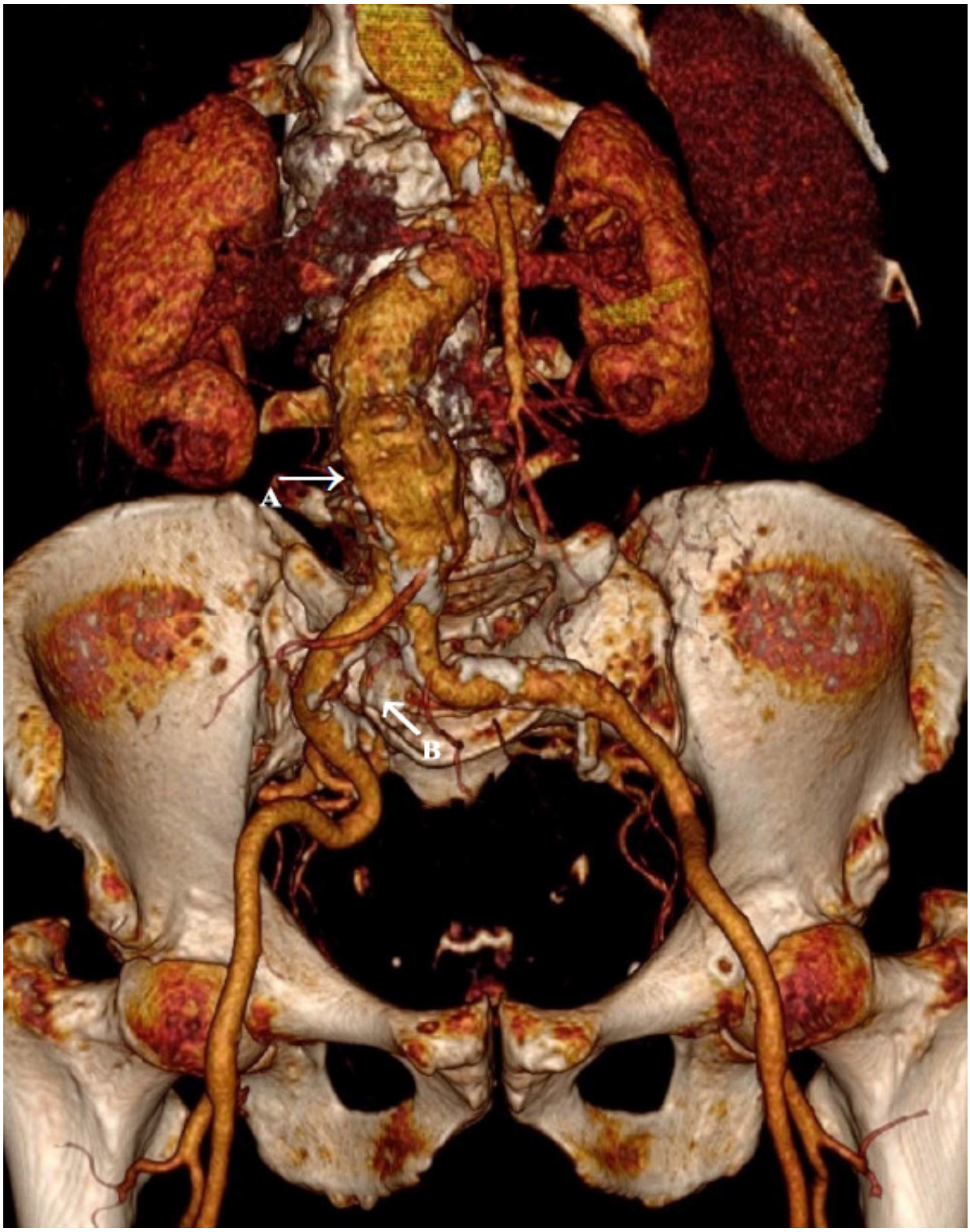

Fig. 1. 3D reconstruction, computed tomography (CT) angiography showing us concomitant presence of aortic aneurism (arrow A) and a right common iliac artery aneurism (arrow B).

Considering the patient's comorbidities and the high anesthetic risk (American Society of Anesthesiologists, ASA 4), an elective endovascular repair using the Branch-Endovascular Aneurysm Repair (EVAR) technique under spinal anesthesia was chosen.

During preoperative planning, a Gore® Excluder® Conformable main body (REF: CXT281412E, SN: 26210501, WL Gore & Associates, Flagstaff, AZ, USA) was selected for use. Its conformability, in combination with the angulation control of the delivery system, was ideal features to

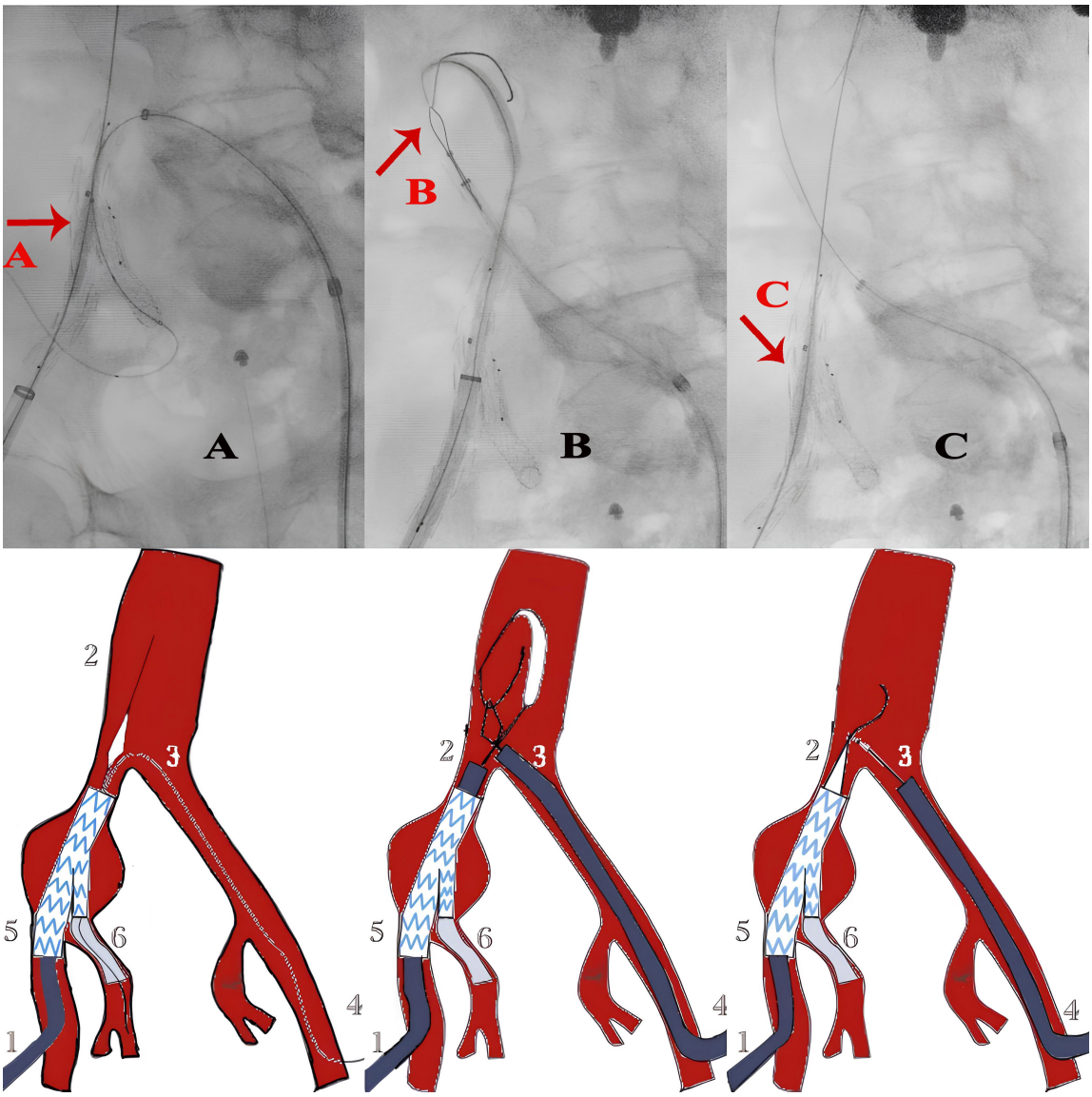

Fig. 2. Phases of tip's retrieval. (A) Tip (arrow A) is lost in right common iliac artery; 1: Dryseal 20 Fr, 2: tip on the guide-wire, 3,4: zip line, 5: E-liac branch, 6: E-ventus; (B) Loop snare (arrow B) captures the stiff guide wire; 1: Dryseal 20 Fr, 2: tip on the guide-wire, 3: loop-snare, 4: introducer, 5: E-liac branch, 6: E-ventus; (C) Tip (arrow C) is retrieved from the right femoral access; 1: Dryseal 20 Fr, 2: tip on the guide-wire, 3: loop-snare, 4: introducer, 5: E-liac branch, 6: E-ventus; (Pictures created by Krita software).

approach the wide aneurysm's beta angle (68°). As well, the absence of bulky fixation systems allowed for the facility of working above the renal arteries in case of proximal extension of disease. An E-liac (REF: 72IB1412L53L44, LOT: 1355547, Artivion, Inc., Kennesaw, GA, USA) stent graft system was chosen to preserve the right hypogastric artery [11], as the asymmetric design of the stents would allow greater adaptability to the vessels' anatomy.

An E-ventus (REF: 91BX5708L-00, LOT: 222386, Artivion, Inc., Kennesaw, GA, USA) balloon-expandable stent graft, previously proven to be safe and effective as a bridging stent [12], was therefore deployed in the right hypogastric artery for this purpose.

Bilateral percutaneous femoral access was obtained via ultrasound-guided punctures.

The E-liac iliac branch device (IBD) was deployed on an extra-stiff guide wire in the right iliac axis following an aortography. A hydrophilic guide wire was positioned in the right hypogastric artery by pre-cannulated access and retrieved using a goose-neck snare from the contralateral femoral access. The E-ventus BX stent graft was successfully released in the right hypogastric artery, as confirmed by angiography. During the retrieval of the IBD tip, the E-ventus balloon was intentionally kept at nominal pressure to shield the stent graft from any deformation induced by the traction forces.

Unfortunately, however, during retrieval the tip detached from the device on the extra-stiff guide wire, ending up in the right common iliac artery (Fig. 2A). A loop snare was therefore introduced via the left femoral access to capture

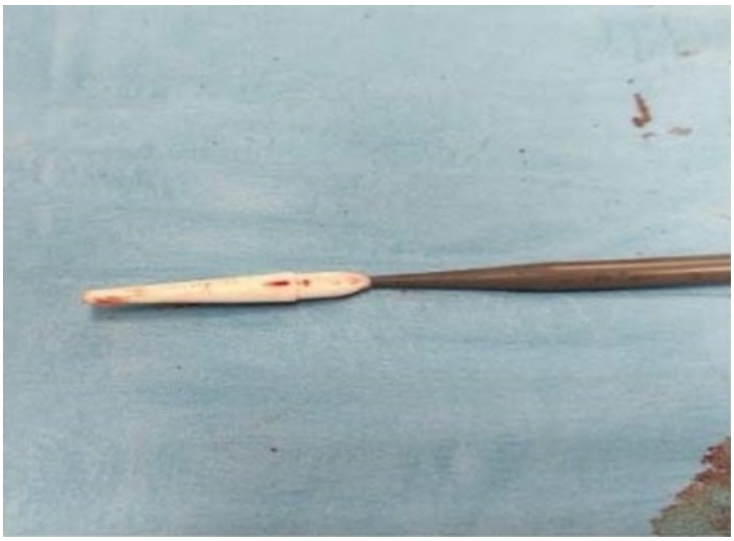

Fig. 3. Retrieval of the tip on the DrySeal introducer.

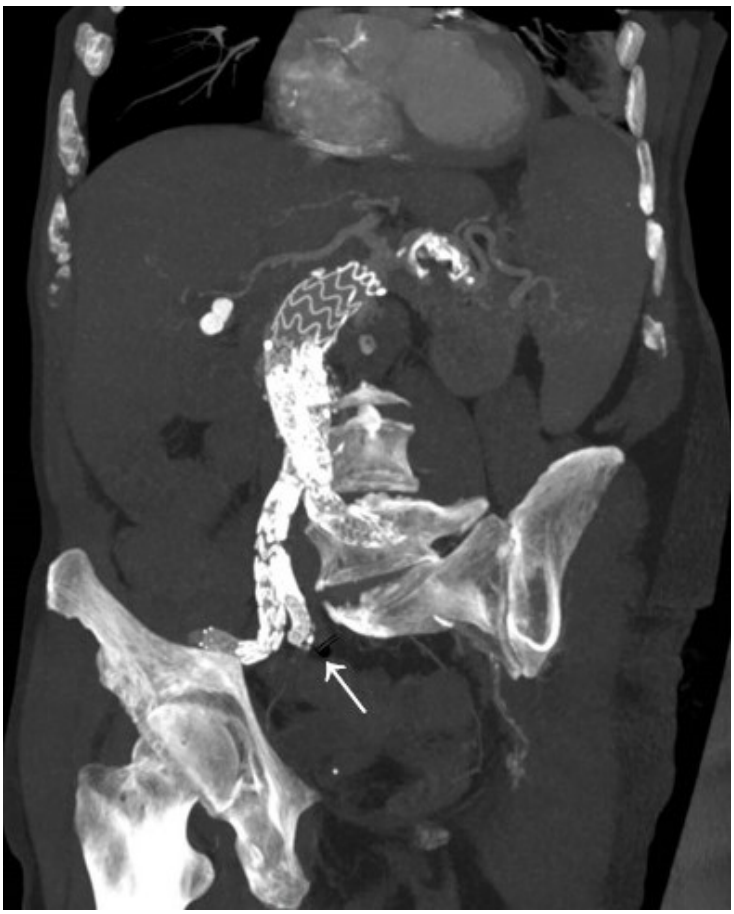

Fig. 4. One-month postoperative CT angiography showing us correct implantation and good patency of the iliac extensions and hypogastric branch (white arrow).

the stiff guide wire and prevent the cranial migration of the tip (Fig. 2B). A 20 Fr DrySeal introducer (REF: 2033, SN: 27591172, WL Gore & Associates, Flagstaff, AZ, USA) was inserted from the right femoral access and, with a coordinated and decisive movement, the guide wire was retracted while advancing the introducer (Fig. 2C), allowing us to capture the tip inside the introducer. In this way, once the introducer was removed, we were able to retrieve the tip with it (Fig. 3).

Once these maneuvers were completed, the main body was positioned across the left femoral access just below the right renal artery to preserve bilateral renal circulation. The contralateral gate was cannulated and the right iliac extension limb deployed to connect the iliac branch to the main body. Finally, the left iliac extension limb was positioned to preserve the left hypogastric artery.

The final arteriography confirmed proper device implantation with no evidence of endoleaks and satisfactory patency of the renal and hypogastric arteries bilaterally. Hemostasis of the femoral accesses was achieved using the Perclose technique with two Perclose ProGlide™ system (6 Fr (2.0 mm), 2090543, 12673-05 , Abbott Vascular, Lakeside Dr Santa Clara, CA, USA) per side.

On the first postoperative day, a color-Doppler duplex scan confirmed the proper deployment of the abdominal endoprosthesis, with no evidence of endoleaks, good patency of the iliac extensions and hypogastric branch, and no complications at the percutaneous access sites. Follow-up and outcomes: The patient was discharged in good general and local condition on the fifth postoperative day: The abdomen was flat and non-tender on inspection, with no signs of distension or abnormal contour. Palpation revealed no palpable or pulsatile masses. There was no rebound tenderness or guarding, and no signs of peritoneal irritation were elicited. The two percutaneous femoral access sites showed no signs of local inflammation, including erythema, edema or increased skin temperature. Auscultation did not detect any vascular bruits over the abdominal arteries. Bilateral femoral pulses were palpable and normosphygmic, with no evidence of ischemia in the lower limbs. A postoperative color Doppler ultrasound of the two femoral access sites revealed no evidence of pseudoaneurysms, hematomas, or other vascular abnormalities. Distal arterial flow was preserved and unobstructed, with no signs of vascular compromise. Laboratory post-operative tests revealed normal white blood cell count (5.75 $\times$ 10^3/uL), C-reactive protein within the normal range (3 mg/L), and reduced hemoglobin levels (pre-operative Hb: 13.5 g/dL, post-operative Hb: 12.3 g/dL). Renal function was stable with no signs of acute kidney injury (pre-operative eGFR: 51.7 mL/min/1.73 m^2, post-operative eGFR 49.9 mL/min/1.74 m^2, CKD 3a). Pharmacological regimen was adjusted to include dual antiplatelet therapy (clopidogrel 75 mg + acetylsalicylic acid 100 mg) for the following six months. A 30-day postoperative follow-up CT angiography confirmed the correct implantation of the endoprosthesis with no complications (Fig. 4). This case has been reported in line with the Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**Supplementary material**).

Discussion

Increased frequency of endovascular procedures has led to a rise in lost or embolized intravascular foreign bodies (IFBs) [8,9]. Mechanisms leading to IFB loss include device fracture (59.3%), loss of control (22.2%), migration (14.8%), and incorrect device deployment (3.7%) [13]. The presence of an IFB can cause severe complications, such as embolism in critical locations including the heart [14], pulmonary arteries, vena cava, peripheral veins and arteries, coronary arteries, hepatic veins, and adjacent soft tissues, all of that associated with significant morbidity and mortality [13].

Table 2. Other experiences in literature.

Endovascular technique	Materials	Citation
Loop snare proximal grab technique	Loop snare	[9,14]
Loop snare lateral grasp technique	Loop snare	[9,14]
Loop snare grasp-guide wire technique	Loop snare and guide wire	[9,14]
Angioplasty balloon catheter technique	Angioplasty balloon catheter	[9,14]
Dormia basket technique	Dormia basket	[9,14]
Filter techniques	Filter	[9]
Aspiration catheter technique	Aspiration catheter technique	[9]
Retrieval forceps technique	Endovascular forceps	[9,14]
Hairpin trap technique	0.010/0.014 guide wire	[14]
Two wire technique	Standard guide wire and stiffer guide wire	[14]

Based on our experience, one of the main factors leading to the loss or embolization of IFBs is the mechanical stress exerted on the device during deployment, particularly when navigating through tortuous or heavily calcified vessels. This stress may induce device fatigue, leading to eventual failure, especially in cases where the deployment process is complicated by anatomical complexities. Another crucial factor is the inappropriate sizing or positioning of the device in relation to the patient's anatomy. An incongruity between the device and the vascular anatomy, particularly in cases where the diameters of the vessels or the angles at bifurcations have not been sufficiently considered, can result in excessive tension on the device's components. Such tension may lead to the detachment of frail parts, such as the tip, or the dislodgement of other device elements.

To mitigate the stress arising from a mismatch between the device and the patient's anatomical characteristics, such as in the case of a narrow iliac bifurcation, it is advisable to prepare the vessels by performing a preliminary kissing-balloon procedure. In the presented case, the iliac bifurcation measured only 14 mm on pre-operative CT angiography, whereas the manufacturer recommends an iliac bifurcation of at least 18 mm. This case highlights the need of caution in treating patients with complex anatomy outside the IFUs, even in high volume centers with great endovascular experience, in order to avoid the risk of complications. In addition to mechanical causes, manufacturing

defects, though rare, can also play a role in device failure. These can include issues related to the materials used, the assembly of the device, or the integrity of the components. Although modern manufacturing processes have strict quality controls, the possibility of such defects should not be entirely dismissed, particularly in complex, multi-component devices used in endovascular procedures. In our case, this possibility of a manufacturing defect was ruled out by the manufacturer which examined the delivery system and the device tip after our report.

According to our hypothesis, the retrieval of the IBD tip with the E-ventus balloon (REF: 91BX5708L-00, LOT: 222386, Jotec, Hechingen, Germany) inflated at its nominal pressure was intended to protect the stent graft from traction and kinking forces. However, this approach may have inadvertently contributed to the detachment of the tip due to the complex interplay of forces at the bifurcation site.

In retrospect, our experience has taught us that to mitigate or minimize the risk of device tip detachment and similar complications in endovascular aortic procedures, several precautions should be taken.

Thorough preoperative imaging and planning are essential [15,16]: high-resolution imaging, such as CT angiography, should be used to assess the aortic and iliac anatomy in detail, including vessel diameter, tortuosity, and calcification. This information should guide the selection of appropriately sized devices and the planning of the deployment strategy.

During deployment and retrieval, devices should be handled with care, avoiding excessive force or rapid movements that could put stress on the device components.

In certain cases, the use of adjunctive techniques, such as ballooning or the placement of additional stents to reinforce the deployed device, can help to reduce the mechanical stress on the device components and minimize the risk of detachment.

After deployment, it is essential to conduct a thorough angiographic verification to ensure that the device is correctly positioned and that there were no signs of mechanical stress or early signs of failure. This should be followed by a careful retrieval of any ancillary devices, such as guide wires or balloons, to avoid inadvertently dislodging or damaging the deployed stent.

Continuous monitoring during the procedure is crucial to detect any early signs of device failure. Should there be any indications of detachment or other complications, prompt intervention, such as repositioning or retrieval, can prevent further adverse outcomes.

However, if a sudden device rupture or potential dislocation occurs during the endovascular procedure, despite thorough preoperative and intraoperative measures, our experience demonstrates that it is essential for the vascular surgeon to be prepared to employ minimally invasive strategies for the retrieval of the IFBs.

A literature review was conducted using the keywords “EVAR” and “endovascular foreign bodies”, which identified a relevant case report similar to our own [17]. The report, described the retrieval of a ring-shaped foreign body, later identified as a DrySeal (DSF 2033, 27590398, UDI-DI 0100733132630042, WL Gore & Associates, Flagstaff, AZ, USA) fragment, lost in the left external iliac artery. Standard snare techniques were ineffective, so the IFB was crossed with a guide wire and captured by inflating a 6 × 40 mm angioplasty balloon within it, then retrieved using a 12F introducer.

During our literature review, various endovascular strategies for IFB retrieval have been documented and summarized in Table 2 (Ref. [9,14]).

In our case, the foreign body was the tip of an IBD on an extra-stiff guide wire, which was detached and strayed during its implantation in the right common iliac artery. The tip had a very tiny lumen, precluding the use of any balloon catheter for its retrieval, and hence we opted for a loop snare technique.

Despite this unforeseen complication, we believe that endovascular management of the aorto-iliac pathology was the optimal choice for this patient, considering his advanced age, physical and mental status, and extensive comorbidities.

Previous studies report that, when feasible, endovascular retrieval of IFBs is the preferred method, though reversion to open surgical retrieval may be necessary in approximately 6–10% of cases [14,18–20].

Conclusions

The rarity of IFBs in endovascular surgery is reflected by the limited case descriptions in the literature. Undoubtedly, the primary strategy should be the prevention of IFBs, ensured through specific knowledge and training in endovascular materials, along with meticulous preoperative clinical and imaging planning to determine the best approach for each case.

Nonetheless, increasing frequency of endovascular therapies has led to a rise in complications, including IFBs. Vascular surgeons must therefore be equipped with a range of techniques and strategies for successful retrieval when they do occur. Whit this in mind, the endovascular approach has consistently shown a high success rate with low morbidity, thereby minimizing the complications associated with open surgical procedures.

Availability of Data and Materials

The datasets used and analysed during the current case report are available from the corresponding author upon reasonable request.

Author Contributions

DT, UMB and LDG designed the study. DT, UMB and LDG treated the patient. IC, AR, NC and MV acquired the data. IC, NC and MV wrote the manuscript.

All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki, and patient provided written informed consent for the report of his case details and imaging studies. The study was exempted from ethical approval by University Federico II of Naples, Naples, Italy.

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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://doi.org/10.62713/aic.3784.

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