

# Successful treatment of unexpected complication during aortic stent-grafting: retrieval of broken stent-graft tip by coaxial technique

Murat Canyigit 

Ömer Faruk Ateş 

Muhammet Fethi Sağlam 

Mete Hidiroğlu 

## ABSTRACT

Thoracic aortic endovascular repair (TEVAR) is increasingly preferred as a treatment of choice in thoracic aortic diseases. Intravascular foreign body is one of the TEVAR-related complications similar to the other endovascular operations. Here, to the our best knowledge for the first time in the English literature, this report presents an extremely rare complication of a broken and stuck tip part of aortic stent-graft in the intravascular space and successful removal by using the coaxial technique.

**T**horacic aortic endovascular repair (TEVAR) has been increasingly preferred as the treatment of choice in thoracic aortic diseases (1). Endovascular treatment has been gaining popularity compared with open surgery due to its less invasive approach and rapid application, and allows the patient to easily return to daily life (2). However, TEVAR is associated with several specific complications including paraplegia, stroke, vascular injuries and local complications. These complications depend on vascular or nonvascular comorbidities, vascular anatomy, equipment, and experience of the provider (3–6).

Intravascular foreign body could be among TEVAR-related complications similar to other endovascular operations (7). Several types of equipment, including guidewire, vascular sheath, or suboptimally uncoiled stents may get stuck in the intravascular space, causing complications (8). Herein, to the best of our knowledge, we present the first report in the English literature of broken and stuck tip part of an aortic stent-graft in the intravascular space and its successful removal using the coaxial technique.

## Technique

### Case admission

A 57-year-old man with 40 pack/year smoking and hypertension history was admitted to our emergency department with a sudden onset of widespread constant left pre-sternal chest pain projecting predominantly to the back. There was no history of coronary artery disease or any known aortic pathology. The patient's consciousness was open, cooperation and orientation were complete. His blood pressure was 150 mmHg systolic over 80 mmHg diastolic, and hemoglobin was 12.7 g/dL. Computed tomography (CT) revealed Stanford type-B dissecting aneurysm at the thoracic aorta extending from T4 level at the 5 mm distal to left subclavian artery through L3 level at the inferior mesenteric artery orifice at the abdominal aorta. The largest diameter of the dissecting aneurysm was 82.7 mm. All the visceral arteries were originating from the true lumen. There was also extensive angulation of the distal thoracic aorta (Fig. 1). Left hemothorax was seen at the pleural space corresponding to a rupture (Fig. 1b).

### Procedure initiation and progression

Following receipt of informed consent and immediate transfer of the patient to the angiography suite, surgical right femoral cut-down and ultrasound-guided percutaneous left femoral and right brachial artery punctures were performed under general

From the Departments of Radiology (M.C.) and Cardiovascular Surgery (M.F.S., M.H.), Ankara Yıldırım Beyazıt University School of Medicine, Ankara, Turkey; Department of Radiology (Ö.F.A. ✉ [omfarat@hotmail.com](mailto:omfarat@hotmail.com)), Ankara Training and Research Hospital, Ankara, Turkey.

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anesthesia. Bilateral 6 F femoral and 6 F right brachial artery sheaths were placed. 5 F Bern catheter and 0.035-inch standard guidewire were advanced via right femoral artery, through angulated thoracic aorta, to the true lumen of ascending aorta dissection. Ultrastiff guidewire (Lunderquist, Cook Medical) failed to proceed inside the catheter. Instead, less firm Amplatz superstiff wire was successfully advanced. 6 F, 70 cm long guiding sheath (Fustar, Lifetech Scientific) was proceeded over the Amplatz wire to the level of the aortic arch, and then ultrastiff guidewire could be advanced. Then, 24 F aortic sheath was placed to femoral artery over stiff wire, and 37×150 mm thoracic stent-graft (Gore Medical) was proceeded to aortic arch, and placed just distal to the left common carotid under distal subtraction angiography (DSA) and fluoroscopic guidance (proximal landing zone was Ishimari zone 2) (9). Left subclavian artery diameter was 15 mm, therefore chimney grafting was considered ineligible due to high risk of proximal endoleak. Thus, it was decided to sacrifice the left subclavian artery. The second (40×150 mm; Gore Medical) and the third stent-grafts (40×100 mm; Gore Medical) were subsequently advanced and placed. The distal end of the third stent-graft was just distal to the level of aortic extensive angulation.

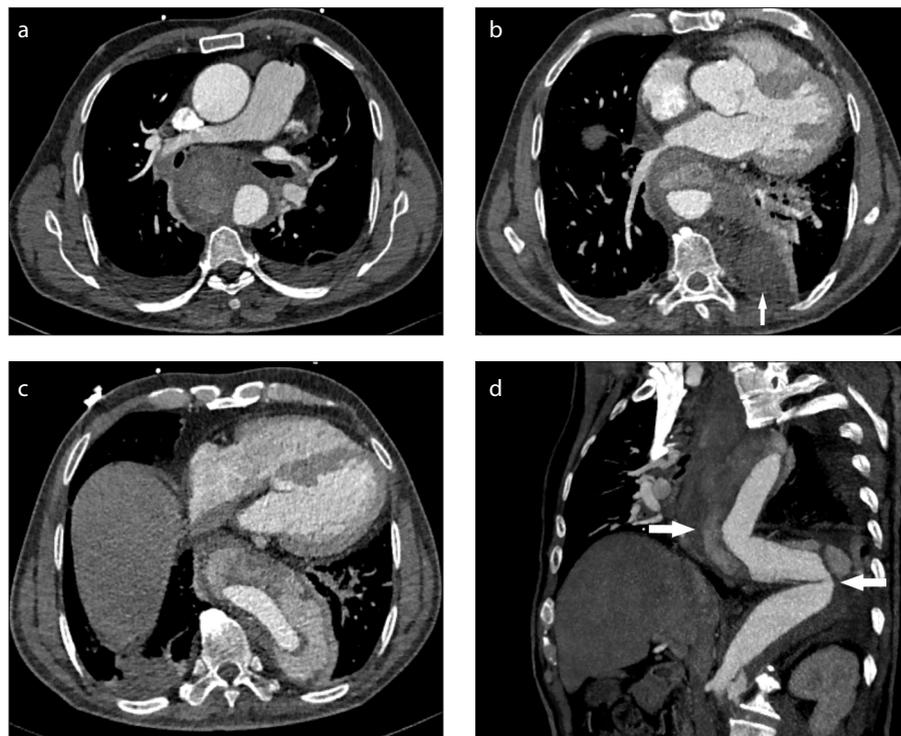
### Complication and resolution

Extensive angulation at the thoracic aorta was the main challenge during the procedure. Upon a failed attempt of fourth stent-graft placement with a longer distal tip part (46×160 mm, Lifetech Scientific) covering angulated area, the stent-graft was removed. Then, a safe through-and-through wire (Amplatz SuperStiff, Boston

Scientific) was generated between right brachial artery and right common femoral artery. Advancement of the stent-graft was tried again over this wire but failed to proceed amidst multiple hard manipulations. Due to excessive strain, the tip of the stent-graft was broken and became stuck over the wire in the aortic lumen as a tubular foreign body. Main body of the stent-graft was first removed and a 12 F, 55 cm guiding sheath was advanced proximal to the newly formed tubular foreign body on the wire. Distal end of the Amplatz wire was passed through one of the three loops of snare (EN Snare, Merit Medical) at the extravascular area; then the snare and its delivery catheter were advanced to the stuck stent tip on the wire, which was then captured and removed using a coaxial technique (Fig. 2). In the coaxial technique, foreign body and wire are caught by the snare after the wire is passed through the foreign body so that the tubular foreign bodies are drawn in a straight direction (10, 11). If the foreign body is already on the wire, the snare ring is directly advanced over this wire and passed over the foreign body to capture it. We used coaxial technique, because in this case the foreign body was on the wire,

and it was almost tubular. 12 F long sheath was also separately used in addition to the snare's catheter for the capture. Stuck tip was kept distal to the aortic sheath, and following the removal of aortic sheath, it was easily removed from the surgical cut-down (Videos 1–4). The aortic sheath was again placed, another stent with short tip (45×100 mm, Gore) was placed to the level where its distal tip reached celiac artery. DSA demonstrated the re-routed blood flow to the true aortic lumen and no leak to the false lumen at the thoracic aortic segment (Fig. 3). The right femoral artery was repaired surgically. Hemostasis was achieved by manual compression on the right brachial artery and the left femoral artery. According to our institution's policy, we chose not to perform prophylactic cerebrospinal fluid drainage leaving it as a rescue solution for postoperative neurologic complications. The patient was otherwise strictly neurologically monitored in the postoperative phase.

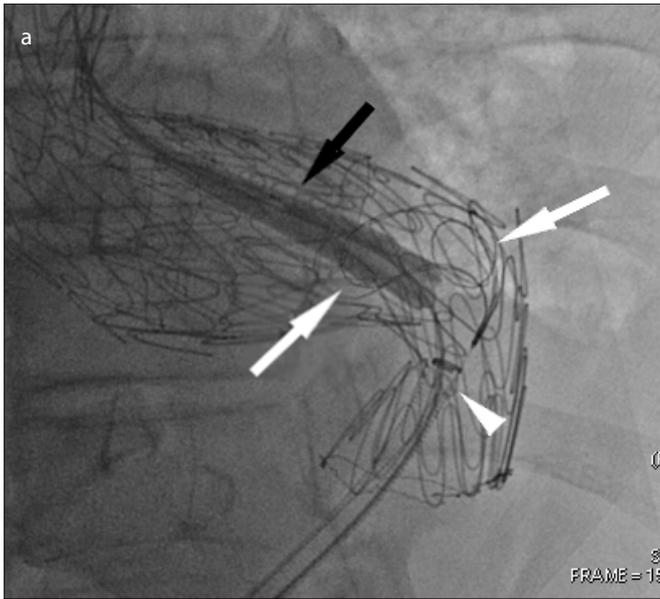
Two hours post-extubation, patient developed left hemiplegia during his recovery in the intensive care unit. A cerebrospinal fluid drainage catheter was placed and left carotico-subclavian bypass procedure was performed. Left hemiplegia was resolved in



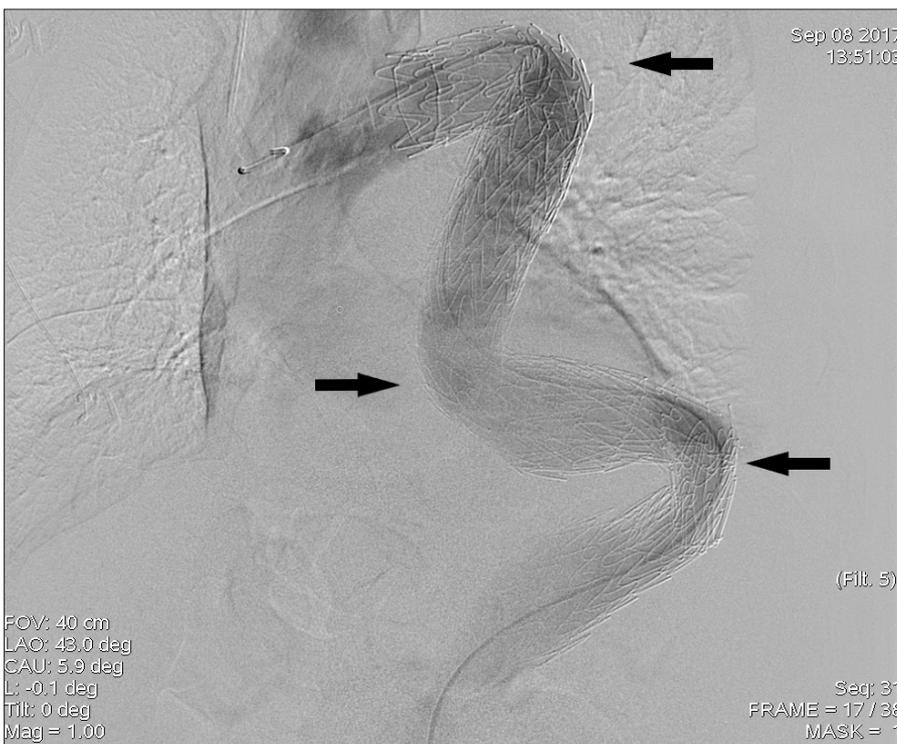
**Figure 1.** a–d. Preoperative computed tomography (CT) images of Stanford type B thoracic aorta dissection. Axial CT image (a) shows the largest dimension of descending thoracic aorta as 82.7 mm. Axial CT image (b) shows left pleural hemothorax with sign of rupture (arrow). Axial (c) and coronal oblique (d) CT images show the tortuosity of the aorta (arrows).

#### Main points

- TEVAR is increasingly preferred as the treatment of choice in thoracic aortic diseases because it is much less invasive, rapidly performed and allows the patient to easily return to daily life.
- Broken and stuck tip part of aortic stent-graft is an extremely rare TEVAR-related complication.
- Coaxial technique is an appropriate approach when the tip of the aortic stent-graft (foreign body) is broken and when it is on the wire.



**Figure 2. a, b.** Foreign body and snare. Intraoperative fluoroscopic image (a) shows broken "tip" (black arrow), loops of snare (white arrows), and guiding sheath (white arrowhead). Intraoperative ex vivo image (b) shows broken "tip" (black arrow), guiding sheath (black arrowhead), loops of snare (white arrow), and catheter of snare (white arrowhead).



**Figure 3.** Intraoperative fluoroscopic image shows the appropriate opening of the stent-grafts and excessive tortuosity (arrows).

12 hours. Postoperative fourth day CT angiography showed totally thrombosed false lumen of thoracic aorta, stable left pleural effusion as well as left lower lung atelectasis. Acetylsalicylic acid 100 mg (once a day for life) and clopidogrel 75 mg (4× 75 mg loading dose first day, followed by once a day for 6 months) were prescribed. Patient was discharged within the same day without any other postoperative adverse event. At 9 months after the procedure, the patient is being followed up uneventfully.

## Discussion

Evolving technology and treatment procedures allow management of cumbersome conditions such as aortic diseases using the endovascular approach. Although these methods are less invasive, they are not immune to risks to patients, and one of the risks is the complete or partial retention of procedure tools in the vessel lumen (12). The present case posed difficulty to the endovascular approach due to excessive angulation caused by descending aortic dissection. Moreover, from our experience, it was hard to proceed with a stent-graft in

previously stented angulation regions. The first two stents that we placed in this case ended just superior to the site of aortic angulation and we failed to proceed the next stent-graft inside the former stents. We used through-and-through wire method to overcome this issue. While we tried to retrieve the failed graft, its distal tip broke and became an intravascular foreign body on the Amplatz wire. We think that fracture of the stent-graft tip was caused by excessive angulation and manipulations.

The best approach to intravascular foreign bodies is to retrieve it, although leaving harmless foreign bodies untouched, mobilizing the foreign body to a less risky location, or relocation are other methods in practice (8, 13). Various snares, vascular retrieval devices, forceps, or retrieval baskets could be used with a wide range of methods including proximal capture, distal wire capture, coaxial capture, lateral capture, balloon technique, or guidewire technique (11, 13). Optimal device and technique are selected based on the type of foreign body and the type of the available tools.

We preferred coaxial technique because foreign body was already on the wire and it had to be retrieved on a linear direction (10). Additionally, we used the long guiding sheath to pinch the foreign body in addition to the snare's delivery catheter due to the large size of the foreign body. Guidewire was advanced on one of the loops, and the foreign body was captured and retrieved by this loop. Guidewire and snare were advanced side by side; guidewire was then proceeded inside the foreign body and then inside the loop, and finally foreign

body was captured (10). In all capture methods including the one that we used, foreign body is constrained between the snare and catheter after its capture by the snare. If the coaxial technique were not successful, another aortic stent-graft could be opened by sending it to the level where the foreign body was. An alternative method could be to exclude it from the vascular system by leaving it between graft and vessel wall or between graft and graft.

In conclusion, it is imperative for the performer to be experienced with the various intravascular foreign body retrieval techniques and to have readily available convenient equipment. Coaxial technique is an appropriate approach when the tip of the aortic stent-graft is broken and when it is on the wire.

**Video 1.** Catching the tip of the stent-graft with snare and snare's catheter.

**Video 2.** Removal of foreign body from stent.

**Video 3.** Recapture of foreign body in the intravascular area with snare's catheter and guiding sheath.

**Video 4.** Demonstration of capture of foreign body.

#### Conflict of interest disclosure

The authors declared no conflicts of interest.

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