Endovascular retrieval of a fractured Optease inferior vena cava filter using endobronchial forceps and intraoperative cone-beam computed tomography guidance

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ABSTRACT

Endovascular retrieval of fractured inferior vena cava (IVC) filters after the manufacturer recommended indwelling time can be challenging and require advanced retrieval techniques. We describe an endovascular retrieval technique of a fractured Optease IVC filter in a 57-year-old woman using endobronchial forceps and intraoperative cone-beam computed tomography guidance. Following incomplete filter retrieval, the location and orientation of fractured strut was confirmed by cone-beam computed tomography venography. The embedded filter fragment was then successfully removed using endobronchial forceps via a transjugular venous approach. In the present report, we highlight the additional value of intraoperative cross-sectional imaging, in conjunction with advanced endovascular techniques, for retrieval of challenging IVC filters. (J Vasc Surg Cases Innov Tech 2023;9:101187.)

Keywords: Endobronchial forceps; Fragmented IVC filter; Image guidance; Intraoperative cone-beam computed tomography; Optease; Pulmonary embolism; Retrievable IVC filter; Venous thromboembolism

The Society of Interventional Radiology clinical practice guidelines define acute pulmonary embolism (PE) with a contraindication against anticoagulation therapy and acute deep vein thrombosis (DVT) with a contraindication against anticoagulation therapy as indications for inferior vena cava (IVC) filter placement.[1] Removal of IVC filters after their recommended indwelling time using a minimally invasive approach is not without additional risks and requires judicious planning and adoption of advanced endovascular retrieval techniques.[2,3] These include conventional computed tomography (CT) venography to understand the IVC filter position and orientation and the presence of any fragmentation and real-time imaging techniques such as two-dimensional angiography and intravascular ultrasound (IVUS). Recently, angiographic imaging systems have evolved to have three-dimensional cone-beam CT (CBCT) capability that creates CT-like cross-sectional images to provide intraprocedural soft tissue imaging and guidance during interventions.

CASE REPORT

A 57-year-old woman presented to our clinic with a chronic indwelling IVC filter (Fig 1) placed several years before for DVT complicated with PE. CT venography showed an anteriorly tilted retrievable Optease filter (Cordis, Miami Lakes, FL; Fig 1, *A-C/1*) suspicious for a posterior strut fracture (Fig 1, *C/2*). The plan was to perform endovascular retrieval of the Optease IVC filter (Cordis; Fig 2, *A*) using the double guidewire and snare technique. The procedure was performed in a hybrid operating room equipped with a robotic C-arm angiography system capable of intraoperative CBCT (Artis Pheno, VE10; Siemens Healthineers, Erlangen, Germany). After ultrasound-guided access of the right jugular and right common femoral veins, 18F sheaths (Flexor Check-Flo Introducer; Cook Medical Inc, Bloomington, IN) were advanced into the IVC from above and below. IVUS demonstrated the inferior portion of the IVC filter abutting the caval wall without any clots in the filter itself. After hooking a soft glidewire through the inferior portion, the IVC filter was captured using an En Snare Endovascular Snare System (Merit Medical, South Jordan, UT). The wire was pulled through and externalized, and a 14F inner sheath was introduced from the femoral venous access (Fig 2, *B* and *C*). However, the wires were slightly off center; thus, we could not collapse the filter into the sheath and remove it. We

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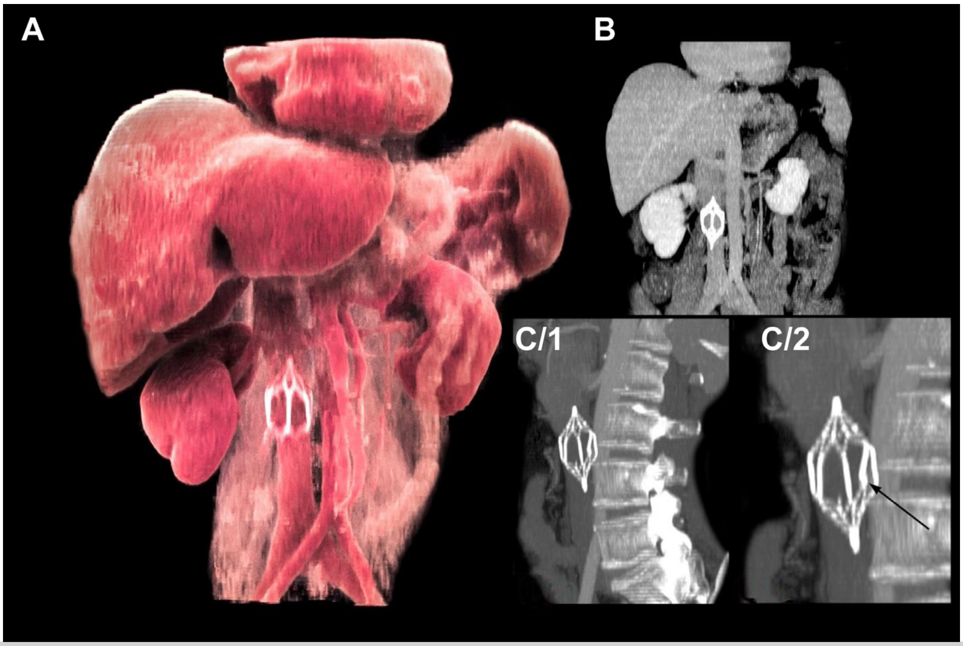

Fig 1. Preoperative imaging studies. **A,** Coronal view of three-dimensional rendered computed tomography angiogram (*CTA*) showing the filter situated right below the renal veins. **B,** Coronal view of maximum intensity projection (*MIP*) CTA. **C/1,** Oblique view of thin MIP CTA. **C/2,** Oblique view of thin MIP CTA at the venous phase suggestive of a posterior strut suspicious for fracture (*black arrow*).

repeated the same procedure from the jugular access (Fig 2, *D*) and, on advancement of the 18F sheath, the filter collapsed. As the inferior hook became visible, we removed the 14F sheath from below and used the En Snare Endovascular Snare System (Merit Medical) to centralize the filter. Opposing tension was applied from above and below the filter, with subsequent advancement of the sheaths, which resulted in collapse of the filter (Fig 2, *E-G*), which was eventually removed (Fig 2, *H*) through the femoral venous sheath. Venography demonstrated no extravasation. Examination of the retrieved IVC filter, and two-dimensional fluoroscopy showed a retained filter strut in the IVC. Following an unsuccessful retrieval attempt with a snare from below, we decided to perform CBCT to understand the relationship of the filter fragment to the caval wall. CBCT venography was performed (5-second digital subtraction angiography protocol; syngo DynaCT; Siemens Healthineers) with 200° C-arm rotation around the patient after injecting 40 mL of 50% diluted contrast for a total duration of 6 seconds using a power injector connected to the femoral venous sheath. Three-dimensional multiplanar and volume-rendered CBCT reconstructions demonstrated a Y-shaped filter fragment, with the main stem embedded in the posterior caval wall and the arms of the Y projecting into the lumen superiorly (Fig 3). A small thrombus was noted adherent to the IVC filter fragment, and heparin was administered. After another unsuccessful retrieval attempt from the top with a snare, retrieval was attempted using endobronchial forceps. The position and orientation of the Y-shaped IVC filter struts as demonstrated by CBCT provided impetus for further retrieval attempts from the jugular approach. An angled 8F sheath was introduced through the 14F and 18F sheaths from the jugular access point to guide the flexible endobronchial forceps (Radial Jaw 4 Hot Biopsy Forceps; Boston Scientific, Marlborough, MA; Fig 4, *A*). The filter fragment was successfully removed from the caval wall via the jugular approach under live fluoroscopic guidance (Fig 4, *B-G*). Ex vivo CBCT of the retrieved IVC filter and fractured fragment was performed to confirm complete retrieval of the Optease filter (Cordis; Fig 4, *H*). No contrast extravasation or thrombus was noted on completion venography. The overall radiation dose was 1975 mGy with 30 minutes of fluoroscopy time. The postoperative course was uneventful. At 1 year of follow-up, multiphase CT demonstrated a patent IVC and no residual IVC thrombus. The patient provided written, informed consent for the report of her case details and imaging studies.

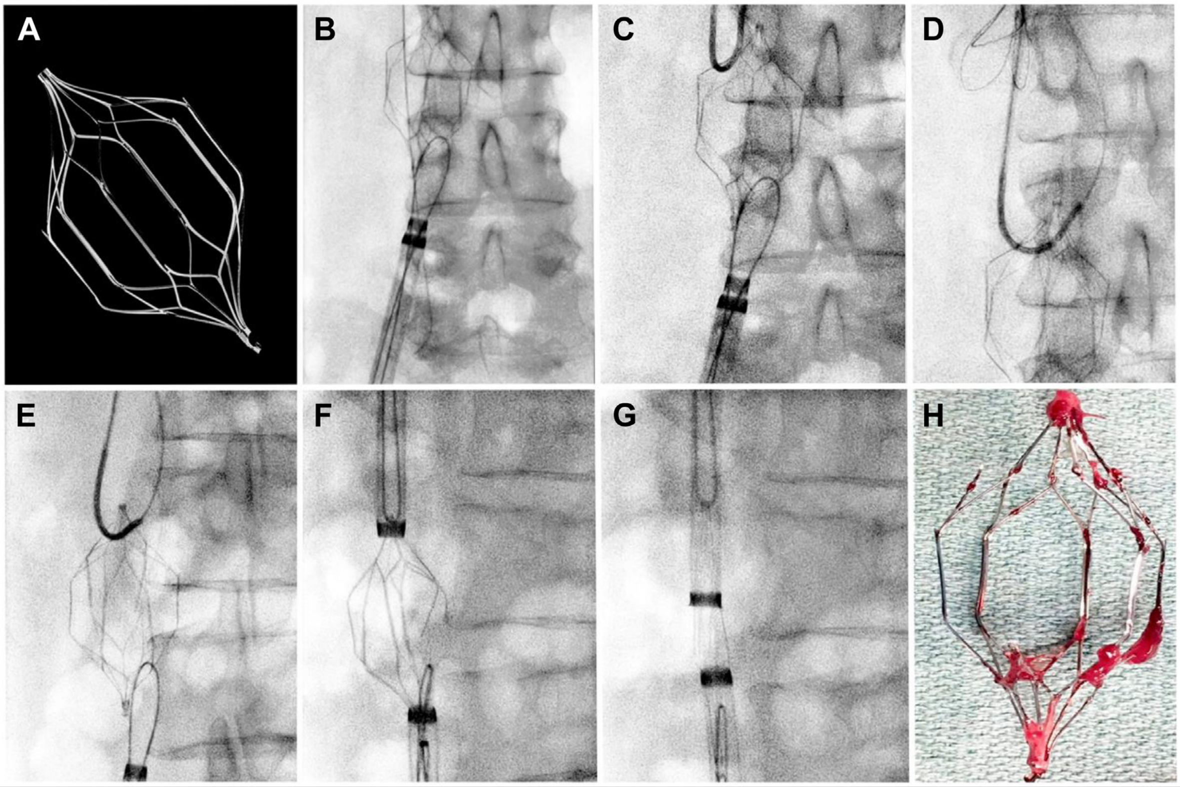

Fig 2. Double guidewire and snare technique. **A,** Optease filter. **B,** The guidewire is looped around the lower strut of the filter and externalized from the caudal direction. Another guidewire is advanced from the cranial direction. **C,** Curved catheter facilitates loop creation around the cranial portion of the inferior vena cava (IVC) filter. **D,** The distal end of the guidewire is snared from above. **E,** The loops around the cranial and caudal struts are completed. **F,** Advancement of the sheaths. **G,** The filter is pulled inside the sheath. **H,** Removed IVC filter with intimal remnants and a broken strut.

DISCUSSION

Retrievable IVC filters are used for temporary bridging of the initial phase of DVT in patients with a high risk of PE. If a retrievable filter is not removed after the appropriate indwelling time, the risk of filter-related complications, such as device migration, IVC thrombosis, filter fracture (and subsequent embolization), IVC perforation, PE, and device infection, is significantly increased.[4] A systematic literature review suggested that caval wall penetration by IVC filter struts occurs in 19% of all cases.[5]

Many retrieval techniques have been developed and can be used separately or combined depending on the clinical scenario. The standard technique is preferred for IVC filters that have not been implanted for long and involves pulling the filter via a hook and snare through a sheath. The other retrieval techniques are considered advanced and are associated with a higher rate of overall complications (20% vs 5%),[6] major complications (5.3% vs 0.4%),[7] fluoroscopy time (23 - minutes vs 4 minutes), and radiation exposure (557.2 mGy vs 156.9 mGy).[8]

The double guidewire and snare technique uses double venous access (jugular and femoral veins) and can be used when an IVC filter is tilted or embedded into the caval wall. The use of the bidirectional pull-back technique reported by Du et al[3] proved useful for cylindrically shaped embedded IVC filter retrieval. However, in the case of strut fracture, this technique can fail to retrieve the entirety of the filter. Endobronchial forceps can then be used for retrieval.[2,9] IVC filter removal is primarily endovascular; however, strut penetration to neighboring structures can require open surgical removal.[10]

In our case, a combination of two advanced techniques were used for IVC filter retrieval, in addition to

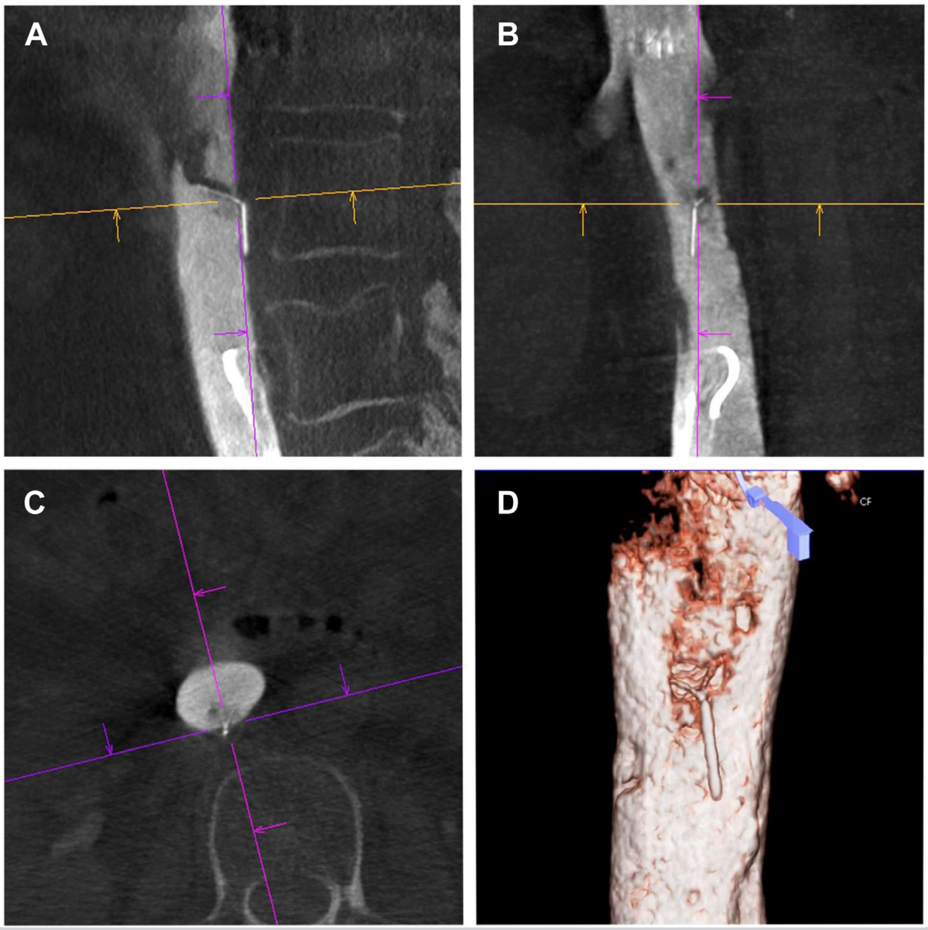

Fig 3. Determining the position and orientation of the fractured strut with intraoperative cone-beam computed tomography (CBCT). Intraoperative CBCT scans showing fractured strut penetrating the inferior vena cava (IVC) and associated thrombus: sagittal view **(A)**, coronal view **(B)**, and axial view **(C)**. **D,** Three-dimensional rendered image of the fractured strut.

intraoperative CBCT, which accounted for 28% of the overall radiation dose. The information from CBCT and CT angiography allowed for safe retrieval of the fractured strut with minimal damage to the caval wall. CBCT provided more information than IVUS regarding the caval wall embedment. Additionally, ex vivo CBCT of the explanted filter confirmed complete retrieval of all filter fragments. Although CBCT plus CT angiography imposed a higher overall radiation dose to the patient, given its valuable contribution to the intraoperative decision-making and safety, we deemed it justified. Without CBCT, it would have been challenging to understand the relationship of the fractured strut and the IVC wall. We assumed a higher radiation dose would have been amassed if repeated digital subtraction angiography scans had been performed. In the future, photon counting CT could be capable of uncovering filter strut penetration in the preoperative setting owing to its superior spatial resolution and decreased beam hardening, further improving image quality.

CONCLUSIONS

We describe retrieval of a fractured Optease IVC filter (Cordis) using endobronchial forceps in conjunction with intraoperative CBCT guidance. In this procedure, intraoperative CBCT angiography provided the exact relationship of the fractured filter fragment to the caval wall and affected the retrieval approach using endobronchial forceps.

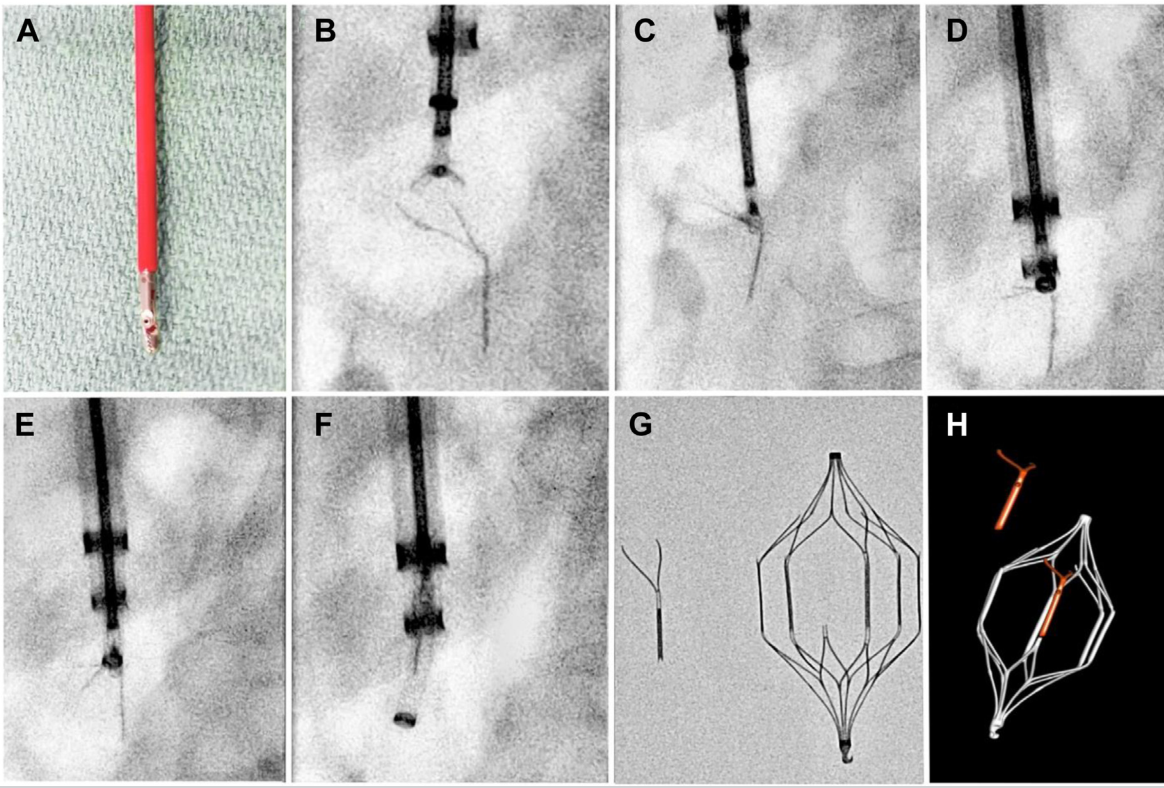

Fig 4. Fractured strut removal with endobronchial forceps. **A,** Endobronchial forceps. **B-F,** Steps of strut removal using the endobronchial forceps technique. **G,** Fluoroscopic view of the fractured strut and IVC filter after removal. **H,** Three-dimensional rendered image of the fractured strut and IVC filter.

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