Extraordinary Cases in Inferior Vena Cava Filter Retrieval

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There has been significant growth in the placement of retrievable inferior vena cava (IVC) filters in recent years.¹ Despite the specific design of these devices to be retrievable, most filters are left in place permanently, in many cases beyond their indicated use.² Recent studies have focused on the greater number of device-related complications associated with retrievable filters, which appears to be positively associated with filter dwell time.^{3–5} The United States Food and Drug Administration (FDA) recognizes the issues associated with these devices, issuing an alert in 2010 prompting retrieval of these devices once no longer indicated.⁶

The development of advanced retrieval techniques has positively impacted retrieval rates associated with IVC filters, particularly difficult to remove or embedded devices.⁷ When used by experienced operators, these techniques are so effective that they essentially remove the “time limit” on filter removal, which can be performed safely regardless of dwell time.⁸ Retrieval of embedded devices can be quite complex. In this article, the authors present five patients in whom extraordinary measures were necessary to achieve technical success and optimal outcomes for each patient.

Case 1

A 66-year-old woman with a history of lung cancer, prothrombin gene mutation, and deep venous thrombosis (DVT) had a Celect (Cook Medical, Bloomington, IN) retrievable IVC filter placed at an outside facility for perioperative mechanical prophylaxis. Once the indication for the filter had passed, retrieval was attempted at the same facility. However, during the retrieval attempt, the filter became significantly disfigured and potentially fractured in multiple places due to reported snare device entanglement. The procedure was abandoned.

She presented for second opinion regarding filter retrieval. On pre-procedural computed tomographic (CT) imaging, several of the struts appeared cranially displaced. There

was fracture of at least one strut, and a small retrocaval hematoma was identified (►Fig. 1a).

During the second attempted retrieval procedure, initial fluoroscopic imaging confirmed that there was significant cranial displacement of the secondary struts and fracture of at least one strut (►Fig. 1b). Cavography demonstrated a dense opacity overlying the filter hook and marked penetration of the primary struts (►Fig. 1c).

Via a 20F sheath, rigid endobronchial forceps (Bryan Medical, Woburn, MA) were introduced and dissection of the tissue about the filter hook was performed. Once the filter hook was exposed, the forceps were utilized to retract the filter apex into the sheath; this required the hook to be bent such that it could be successfully withdrawn from the fibrin cap (►Fig. 1d). Attention was then turned to the embedded, fractured strut. Utilizing the same forceps, this strut was captured and successfully retrieved (►Fig. 1e).

Cavography following filter retrieval demonstrated irregularity at the prior implantation site, likely related to retained fibrin and scarring from the filter. Prolonged balloon angioplasty with an 18-mm balloon (Atlas, Bard Peripheral Vascular, Tempe, AZ) was performed, with completion cavography demonstrating brisk flow through the IVC (►Fig. 1f). ►Fig. 1g shows the filter components following retrieval.

Case 2

A 22-year-old woman with a past medical history of partial C5–C6 spinal cord injury and prophylactic placement of a TrapEase (Cordis Corp., Miami Lakes, FL) permanent IVC filter presented after imaging demonstrated that the filter was fractured, with a portion of a strut embolized to the liver (►Fig. 2a). Since placement, the patient had not developed DVT. She presented for removal of the permanent filter given the risk for future component embolization and lack of persistent indication for mechanical pulmonary embolism (PE) prophylaxis.

Fig. 1 (a) Postcontrast axial computed tomographic (CT) image demonstrating several cranially displaced struts (arrowhead) and a small retrocaval hematoma (arrow). (b) Spot fluoroscopic image showing significant cranial displacement of the secondary struts (arrows) and fracture of at least one strut. (c) Inferior vena cavography demonstrating significantly embedded filter hook (arrowhead) and penetration of the primary struts (arrows). (d) Spot fluoroscopic image of filter retraction via forceps. (e) Spot fluoroscopic image demonstrating forceps retrieval of fractured strut. (f) Postremoval digital subtraction inferior vena cavography demonstrating patent IVC. (g) Explanted filter and fractured struts.

During the filter retrieval procedure, scout imaging confirmed that the filter was fractured in multiple places, and that a single strut was missing, representing the embolized component (►Fig. 2b).

Common femoral and jugular access was utilized. Via a 16F sheath from the jugular approach and an 18F sheath from the femoral approach, rigid endobronchial forceps were utilized to withdraw the cranial and caudal portions of the filter into each sheath (►Fig. 2c).

Utilizing the Excimer laser sheath (Spectranetics, Colorado Springs, CO), photothermal laser ablation was performed from each access until the filter was successfully removed. Multiple small embedded fragments remained in the IVC,

which were successfully freed and could be removed with forceps (►Fig. 2d).

Cavography following filter removal demonstrated mild narrowing at the prior implantation site, which resolved with 18 × 40 mm balloon angioplasty (►Fig. 2e). ►Fig. 2f shows the extracted filter components.

Case 3

A 27-year-old woman with a past medical history of DVT, May-Turner syndrome, and OptEase (Cordis Corp.) potentially retrievable IVC filter placement 5 years previously presented for a second attempt at retrieval. The initial

Fig. 1 (Continued)

attempt at retrieval, which was performed at the facility where the filter was placed, had failed.

Initial cavography demonstrated a large, eccentric filling defect adjacent to the hook of the IVC filter (**Fig. 3a**). The filter was also noted to be fractured in multiple places. Via an 18F sheath from a femoral venous access, endobronchial forceps were utilized to dissect the tissue encasing the filter hook. Once the hook could be snared, the Excimer laser sheath was utilized for photothermal ablation of fibrin; however, only a portion of the filter could be collapsed due to significant resistance at the cranial aspect of the filter from the fractured, embedded strut (**Fig. 3b**).

Internal jugular access was subsequently obtained. Via a 16F sheath, a loop wire snare was formed through the cranial aspect of the filter with a reverse catheter and exchange length wire. Photothermal ablation was performed, and the cranial aspect of the filter was collapsed into the femoral sheath, thereby removing the filter from the IVC (**Fig. 3c**).

Several embedded struts as well as a cylindrical radioopaque foreign body remained after retrieval of the filter (**Fig. 3d**). These were removed with forceps; the cylindrical

foreign body represented a sheared balloon catheter fragment (**Fig. 3e**). Completion cavography demonstrated resolution of the large eccentric filling defect, which was believed to be secondary to the retained balloon fragment (**Fig. 3f**).

Case 4

A 68-year-old man with a history of DVT presented with chronic ilio caval thrombosis secondary to an Eclipse (Bard Peripheral Vascular, Tempe, AZ) potentially retrievable IVC filter placed 4 years previously. For the past several months, the patient had developed significant bilateral lower extremity edema, to the extent that he was no longer able to exercise. Preceding CT imaging demonstrated ilio caval thrombosis extending to the level of the filter (**Fig. 4a**). He presented for possible filter removal and venous recanalization.

Initial scout imaging demonstrated that one of the filter struts was significantly displaced cranially (**Fig. 4b**). Bilateral femoral venous access was obtained. Via each access, a hydrophilic wire (Glidewire, Terumo, Tokyo, Japan) along with a 5F Kumpe catheter (Cook Medical) was utilized to

Fig. 2 (a) Axial postcontrast CT image demonstrating embolized strut to the liver (arrow). (b) Spot fluoroscopic image demonstrating multifocal fracture of the IVC filter. (c) Spot fluoroscopic image demonstrating forceps-assisted collapse of the filter into jugular and femoral sheaths. (d) Spot fluoroscopic image demonstrating forceps retrieval of fractured, embedded fragments (arrowheads). (e) Postremoval digital subtraction inferior vena cavography demonstrating no flow-limiting stenosis or caval injury. (f) Explanted filter with fractured components.

Fig. 3 (a) Inferior vena cavography demonstrating filter hook embedded in dense opacity (arrow). Note multifocal filter fracture. (b) Spot fluoroscopic image of the laser sheath-assisted photothermal ablation via femoral access; complete collapse of the filter was not possible due to the embedded, fractured strut (arrows). (c) Spot fluoroscopic image of the filter collapse via both femoral and jugular access. (d) Spot fluoroscopic image of multiple embedded struts (arrows) and sheared balloon catheter fragment (arrowhead). (e) Explanted filter, strut fragments, and sheared balloon catheter. (f) Inferior vena cavography demonstrating brisk flow through the IVC postremoval of filter and balloon catheter.

Fig. 4 (a) Postcontrast, coronal reconstructed CT image demonstrating ilio caval thrombosis (arrow). (b) Spot fluoroscopic image demonstrating significant cranial displacement of a filter strut (arrow). (c) Digital subtraction femoral venography demonstrating ilio caval occlusion with drainage via lumbar collaterals (arrows). (d) Post-stent placement digital subtraction venography demonstrating brisk flow through the reconstructed IVC and iliac veins.

cross the occluded segment and obtain access cranial to the filter. Venography from the femoral accesses confirmed caval occlusion with drainage via lumbar collaterals (►Fig. 4c).

Internal jugular access was obtained, and a 16F sheath was placed cranial to the filter. Initial attempts at capturing the hook of the filter with a snare device failed. Endobronchial forceps were introduced, utilized to dissect the hook free from fibrin, and subsequently remove the filter.

From the femoral accesses, 14-mm stents (SMART, Cordis Corp.) were deployed across the occluded segment of the IVC and iliac veins, and postdilated to 14 mm. Completion venography demonstrated brisk flow through the reconstructed IVC and iliac veins (►Fig. 4d).

Case 5

A 75-year-old man with a history of DVT/PE had an OptEase potentially retrievable IVC filter placed at an outside institution. During the subsequent retrieval attempt, a wire and

microcatheter were entangled within the filter and could not be disengaged. The retrieval attempt was aborted, and via the right common femoral sheath, a heparin infusion was initiated. The patient was transferred to the authors' facility for further management.

Initial imaging demonstrated that the filter was in nearly transverse position and potentially folded upon itself; furthermore, it was entangled with a 0.014-in wire and microcatheter (►Fig. 5a). The wire and catheter entered via a 9F right femoral sheath. Via internal jugular access, initial attempts were made to reduce the wire with rigid endobronchial forceps. These attempts were unsuccessful due to the degree of entanglement. Left femoral venous access was obtained, and a 16F sheath was placed. Via this access, forceps were introduced to straighten the filter, enabling snaring of the filter hook from the jugular access (►Fig. 5b).

From the jugular access, forceps were utilized to withdraw the filter/wire complex into the sheath. Utilizing intermittent photothermal ablation with the Excimer laser sheath, the

Fig. 5 (a) Spot fluoroscopic image demonstrating malpositioned filter entangled with a wire and microcatheter. (b) Spot fluoroscopic image showing manipulation of the filter utilizing forceps in preparation for snaring. (c) Spot fluoroscopic image demonstrating incomplete reduction of the filter/wire complex within the jugular sheath (arrow). (d) Fluoroscopic image showing manipulation of the filter/wire complex utilizing forceps before advancement of the right femoral sheath (arrow). (e) Explanted filter along with wire and microcatheter. (f) Postremoval digital subtraction cavography demonstrating brisk flow through the IVC without evidence of caval injury. (g) Postcontrast coronal reconstructed CT image demonstrating normal caval caliber and absence of foreign body (arrow).

filter/wire complex was partially collapsed into the jugular sheath; however, complete reduction of the complex was not possible (►Fig. 5c). Attempts at further collapse from the left femoral sheath were not successful.

Via the preexisting 9F sheath in the right femoral vein, a wire was advanced into the IVC. Over this wire, leaving the foreign body wire to the side, a 28F Dry Seal (W.L. Gore, Tempe, AZ) sheath was advanced to the filter/wire complex. Via this sheath, using forceps, the filter/wire/catheter complexes were removed in their entirety (►Fig. 5d, e). Comple-

tion cavography demonstrated brisk flow through the IVC without evidence of caval injury (►Fig. 5f). CT imaging at 1 month postprocedure confirmed normal caval caliber and no retained foreign body (►Fig. 5g).

Conclusion

Most IVC filters can be retrieved with standard sheath and snare techniques, which are familiar to most interventional radiologists. Advanced IVC filter retrieval techniques, as

Fig. 5 (Continued)

described in this article, are critical in the removal of embedded filters. In these instances, familiarity with these techniques, and the judgment when to not attempt to utilize them, are the responsibility of each interventional radiologist for whom IVC filter retrievals are a part of their practice.

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