Inferior vena cava filter removal after prolonged dwell time of 2310 days

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Inferior vena cava filters are commonly placed for a variety of indications, often when anticoagulation is contraindicated. Although technical success is high and complication rates low, there are complications that are important to be aware of. We present the case of a 29-year-old woman with a prolonged filter dwell time resulting in complications.

Inferior vena cava (IVC) filter placement is designed to prevent pulmonary embolus by trapping venous emboli and has become a relatively common procedure with excellent technical success (99%) (1). Indications for placement are divided into accepted, relative, and prophylactic categories. Accepted indications include documentation of venous thromboembolism (VTE) plus one or more of the following: contraindication to anticoagulation, progression/recurrence of VTE while anticoagulated, complication of anticoagulation, life-threatening pulmonary embolus, and inability to achieve/maintain therapeutic anticoagulation. Optional filters now exist in which a filter can be retrieved percutaneously. Ongoing monitoring and follow-up evaluation to assess anticoagulation status and need for filter are required, as long-term complications exist. Complications include IVC perforation (0%–41%), filter migration (0%–18%), filter fracture (2%–10%), and IVC occlusion (2%–30%) (2). Caval perforation can result in injury to adjacent structures, although most are asymptomatic. Extreme examples include gastrointestinal hemorrhage and aortic dissection (3, 4). Migration of fracture fragments can cause serious complications, such as life-threatening arrhythmias and myocardial perforation with cardiac tamponade (3). The Food and Drug Administration recommends that physicians responsible for the ongoing care of patients with retrievable filters consider removing the filter as soon as protection from pulmonary embolus is no longer needed (5). Filter removal is not always straightforward.

CASE REPORT

A 29-year-old black woman presented with fulminant hepatic failure secondary to autoimmune hepatitis. She developed hyperammonemia with encephalopathy, increased intracranial pressure, and cerebral edema. Cadaveric liver transplantation was performed. On postoperative day 1, head computed tomography (CT) for cerebral edema monitoring revealed right frontal lobe parenchymal hemorrhage. On postoperative day 5, follow-up head CT revealed interval multifocal cortical infarctions. Lower-extremity paresis developed, resulting in prolonged bedrest. Surveillance lower-extremity venous duplex 2 weeks postoperatively was negative.

The patient's clinicians elected to have an IVC filter placed for prophylaxis in the setting of intracerebral hemorrhage and increased risk of thromboembolic disease secondary to prolonged immobility. A retrievable G2 IVC filter (Bard Peripheral Vascular, Tempe, AZ) was placed via the right common femoral vein percutaneous approach. During the procedure, a venocavagram identified nonocclusive infrarenal mural thrombus. The filter was placed superior to the thrombus with the filter tip at the renal vein level. This represents the conversion of a prophylactic to an accepted indication, with confirmation of IVC thrombus in the setting of hemorrhage. At implantation, the filter long axis was parallel with the caval wall without tilt. The patient was discharged to a rehabilitation facility. She continued follow-up with the transplant clinic with routine sonographic and Doppler evaluation of the transplanted liver.

Over 6 years later, CT of the abdomen and pelvis performed for an unrelated indication incidentally revealed fracture of two filter struts *(Figure 1a)*. One was located in the retroperitoneum posterior to the abdominal aorta without evidence of aortic perforation *(Figure 1b)*. The second migrated distally and was lodged within a first-order branch of the middle hepatic vein *(Figure 1c)*. The filter was tilted >15° right anterolaterally; however, the tip was not embedded within the caval wall. Multiple struts had caused caval perforation posterolaterally, with tips located within retroperitoneal fat. Interventional radiology was consulted for removal. The length of dwell time was 2310 days. Prior to removal, bilateral lower-extremity venous duplex revealed no evidence of deep venous thrombosis. Indications for filter continuation were no longer present (the patient was now ambulatory, there was no documented deep venous thrombosis,

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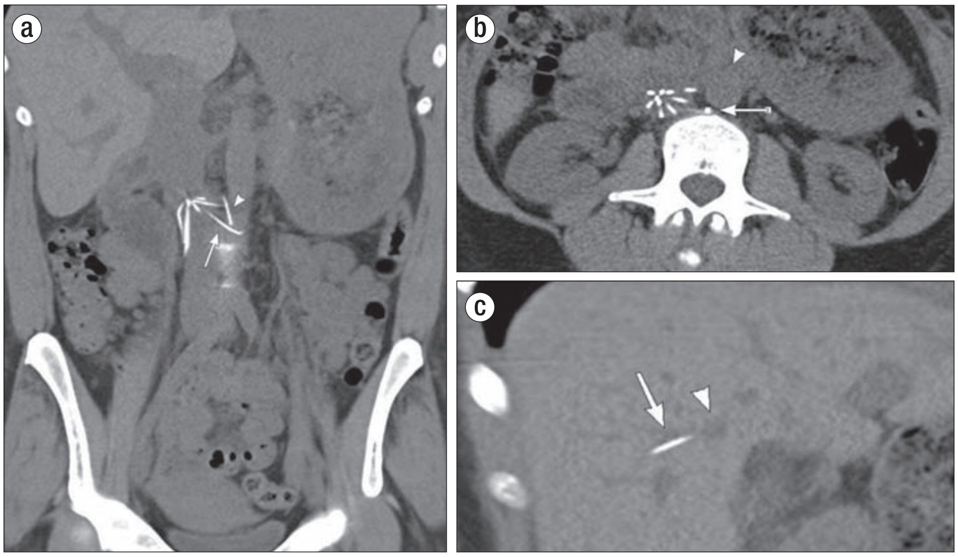

Figure 1. Preretrieval nonenhanced CT images. **(a)** Inferior vena cava perforation (arrow) and fractured strut (arrowhead). **(b)** Fractured strut (arrow) within retroperitoneal fat posterior to the abdominal aorta (arrowhead). **(c)** Migration of fractured strut (arrow) within the middle hepatic vein (arrowhead).

and there was remote hemorrhage). Given preretrieval findings, informed consent was obtained for anticipated complicated retrieval.

In the interventional suite, a vascular sheath was positioned in the right internal jugular vein after ultrasound-guided Seldinger technique access. An IVC venogram confirmed IVC perforation *(Figure 2)*. Conventional snare techniques were unsuccessful at retrieval. An advanced snare technique was then employed. Two coaxial sheaths were positioned over an Amplatz wire (Cook Medical Inc., Bloomington, IN). Two wires were advanced, one anterior and the other posterior to the filter. The anterior wire was exchanged for a snare system. The distal end of the posterior wire was then snared and retracted, capturing the filter *(Figure 3a)*. The filter tip was retracted into the inner sheath. The filter was collapsed within the outer sheath while the tip was stabilized within the inner sheath and then removed. Intraoperative XperCT (Philips Healthcare, Best, Netherlands) confirmed fractured fragments in the retroperitoneum and liver. A postretrieval IVC venogram showed no extravasation of contrast, stable position of the migrated struts *(Figure 3b)*, and mild luminal narrowing at the site of filter implantation. Angioplasty with an 18 mm balloon at the site of luminal narrowing improved luminal diameter and flow on repeat venography. Also on postretrieval venography, stenosis was identified at the superior IVC anastomosis from the transplant surgery, resulting in reflux into the hepatic veins. This stenosis and secondary reflux was the postulated etiology of strut fracture migration to the middle hepatic vein, preventing possible cardiac embolization. All catheters and wires were removed without complication. Hemostasis was achieved by manual compression. The patient tolerated the procedure well and left the interventional suite in stable condition. Prophylactic anticoagulation was initiated.

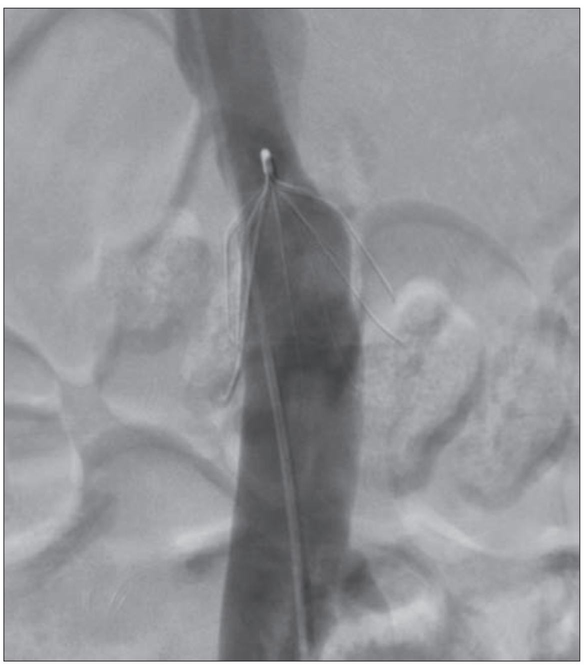

Figure 2. Venogram confirming inferior vena cava perforation.

DISCUSSION

This case demonstrates advanced IVC filter retrieval. Advanced retrieval, generally considered to be safe, is characterized by prolonged fluoroscopy time, use of nonstandard retrieval techniques and devices, filter fracture, filter tip embedding in the IVC wall, and retrieval failure (6). Nonstandard techniques include advanced snare maneuvers, laser-assisted sheath tissue ablation, microdissection with rigid or flexible forceps, and combinations of these methods.

How is it that a filter in good position initially can go on to require complicated retrieval? Electron microscopic analysis of filter fracture has identified foreshortening and flattening in vivo motions transmitted from the IVC to the filter (7). Transmitted motion can ultimately result in one of two fracture modes: high-cycle metal fatigue secondary to accumulated damage and metal overload sustained from acute stress (7). Histologic analysis of filter-adherent tissue on removed filters showed neointimal hyperplasia or fibrosis in 96% of cases (7). Once a filter tip or strut abuts the caval wall, neointimal hyperplasia or fibrosis can cause embedding, thus altering the physiologic stress on the filter. To reduce this risk, if there is malposition of a retrievable filter at the time of insertion (e.g., increased tilt), the filter should be removed and a new device inserted (1).

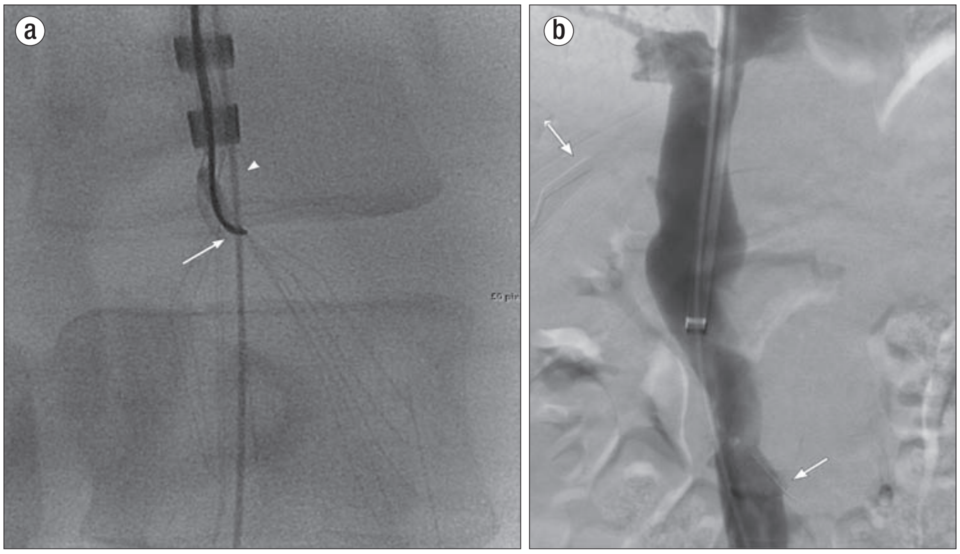

Figure 3. (a) Advanced snare technique. Snare system (arrow) retracting posterior wire (arrowhead) to capture the filter. Coaxial sheaths also visualized superiorly. **(b)** Postretrieval venogram without extravasation of contrast, fractured struts (arrows), and mild stenosis superiorly.

Multiple statistically significant characteristics on preretrieval CT imaging can help prospectively identify potential complicated retrievals. These include tilt angle in mediolateral and anteroposterior directions (>15° cutoff), tip embedding (tightly opposed to IVC wall), strut perforation, and dwell time (6). Some characteristics are anecdotally related, such as increased tilt angle and tip embedding. The degree of filter strut perforation is based on a grading system: grade 0, all struts confined within the lumen; grade 1, strut external but immediately adjacent to the IVC wall; grade 2, struts completely outside IVC lumen; and grade 3, struts adjacent to or inserting into an adjacent organ or retroperitoneal structure (6). Identification of these factors can aid in procedure planning, proper consent, and referral to a tertiary center if needed.

Although retrieval success remains high after more than 1 year after implantation (100% in one study), a prolonged dwell time >180 days has a significant increased risk of complicated retrieval (odds ratio, 2.3) (6, 8). Thus, some authors suggest considering preprocedural CT in the setting of prolonged dwell time (6). In the past, our interventional radiology department relied on referrals for removal. Unfortunately, this patient was lost to follow-up without referral as soon as embolic protection was no longer required. In light of growing data regarding long-term complications and success of filter tracking with dedicated clinics, a new system was implemented. With a patient database and tracking by the interventional radiology department, ordering clinicians are contacted after implantation regarding the evaluation of ongoing filter need with encouraged removal. Abdominal radiographs are initiated at 6 months postimplantation to assess for complications. Retrieval rates have continued to increase since initiation of this proactive and structured follow-up. Our case exemplifies prolonged dwell time, grade 3 strut perforation, and increased tilt angle. Prior knowledge of these characteristics on preprocedural imaging allowed for planning of a successful complicated retrieval with advanced snare techniques.

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