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Case Report

Tine after tine: a varied approach to the removal of a long-standing IVC filter

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ABSTRACT

Inferior vena cava filters are important tools used to help prevent life-threatening pulmonary embolisms in hospitalized patients with contraindications to pharmacological prophylactic anticoagulation. This is a case report of a patient who had an inferior vena cava filter placed after a traumatic subdural hematoma. He made a complete recovery but was lost to follow-up until he presented 1825 days after filter deployment with abdominal pain discovered to be from penetration of the filter tines outside the lumen and into adjacent structures. We describe a case complicated by fibrotic tine entrapment with penetration to surrounding structures and discuss the technical approach used to free and eventually remove the long-standing filter.

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Case report

A 27-year-old man presented to the clinic with right lower quadrant abdominal pain and was referred to emergency room for possible appendicitis. Patient had a history of traumatic subdural hematoma and prolonged hospitalization 5 years ago. A Celect Gunther Tulip (Cook, Indiana) inferior vena cava (IVC) filter was placed uneventfully at that time after he developed bilateral pulmonary embolisms while having a contraindication for anticoagulation. He was lost to follow-up

until he presented with his current symptoms. Physical examination was significant for a pulse of 106 beats per minute, a positive Rovsing sign and normal bowel sounds. Laboratory studies were significant for white count of $11.5 \times 10^3/\text{UL}$ and an elevated hemoglobin and hematocrit of 17.8 g/dL and 51.5%, respectively. At this point, a computed tomography (CT) scan was done to assess the abdomen and pelvis. Findings were negative for appendicitis, but 4 of the 12 tines of the Celect IVC filter showed extraluminal penetration. These tines were shown abutting the aorta, intestines, and lumbar

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spine which lead to evaluation for possible filter retrieval (see Fig. 1). Patient was admitted with vascular surgery and Interventional Radiology consultation. The surgical management of this particular patient would have required, at the very least, the presence of a general surgeon and a vascular surgeon. Because there was no evidence of damage to the intestines or the aorta, surgical removal of this IVC filter would have required an exploratory laparotomy with a right sided medial to lateral visceral rotation for exposure of the IVC. Proximal and distal control would have to be obtained. The IVC would have to be incised; the IVC filter removed, and most likely a patch repair of the vein would have had to be undertaken. This surgical intervention may have resulted in any number of complications including wound infection, damage to adjacent organs, and risk of venous thrombosis. In addition, the length of stay for his hospitalization would be expected to have been between 5-7 days postoperatively. Taking this into consideration and after review of the pertinent studies, the decision was made to attempt endovascular retrieval.

After informed consent was obtained, the patient was taken to the interventional radiology room and prepped appropriately with access obtained through his bilateral femoral veins and the right internal jugular vein. Initially, the retrieval neck sheath was advanced to just cephalad to the filters hook, and an IVC gram study was obtained in the oblique projection with the findings in

the venogram concurring with the CT scan findings; those showed hook embedment into the posterior medial IVC wall and 4 of 12 tines with extraluminal penetration (see Fig. 2). An Ensnare (Merit, Utah) device and a 5 French IM catheter (Cook, Indiana) were used from the cephalad approach to try and dislodge the embedded hook but were unsuccessful. Endobronchial forceps (Olympus, Pennsylvania) were then advanced through the right femoral vein sheath and were used to grasp the extraluminal tines individually and reposition them inside the IVC lumen (see Fig. 3). Following repositioning of all the tines inside the IVC, another venogram was performed to confirm all filter tines were located inside the lumen and ensure no extravasation was evident. An Advantage (Terumo, New Jersey) wire and EV3 (Covidien, Minnesota) balloon were used to cannulate lateral to the implanted filter hook and attempt to dislodge it medially. Then, an EV3 (Covidien) snare device was advanced through the right internal jugular vein sheath to grasp the tines of the filter near the neck of the device. While pushing with the inflated balloon in a caudal to cephalad motion, the snare was used to abruptly dislodge the filter hook from the wall of the IVC. The filter was then manually retracted upward through the right internal jugular vein sheath and maneuvered to allow hook accessibility and removal using the 10 French neck sheath. A completion IVC gram was obtained from a right femoral sheath injection with no evidence of active venous extravasation, gross IVC injury, or arterial venous fistulas (see Fig. 4).

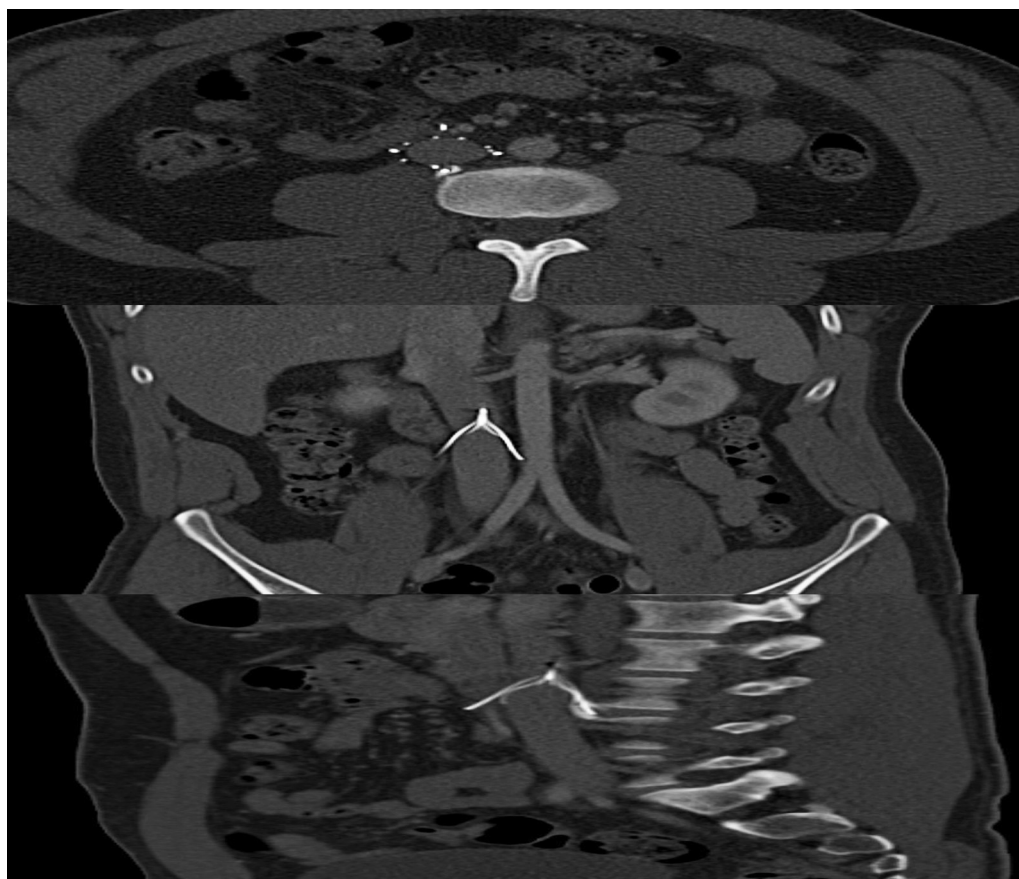


Fig. 1 – Axial, coronal, and sagittal CT slices showing the extraluminal impingement of filter tines onto adjacent structures. CT, computed tomography.

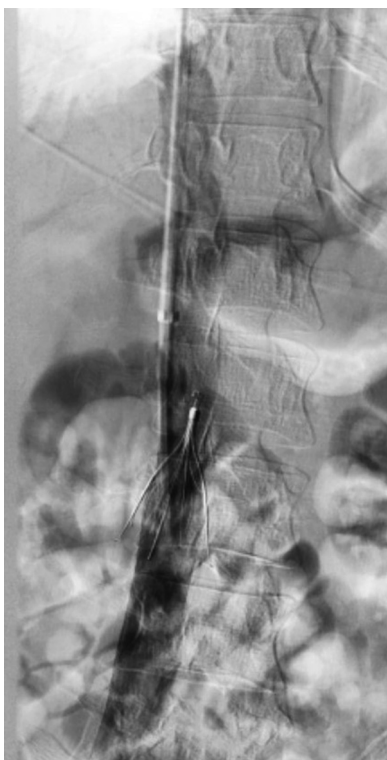


Fig. 2 – Initial IVC venogram concurring with CT findings. CT, computed tomography; IVC, inferior vena cava.

Patient tolerated the procedure well and was transferred to the floor in stable condition. The patient's abdominal pain resolved by the following day and a follow-up CT with IV contrast was performed with no evidence of retroperitoneal

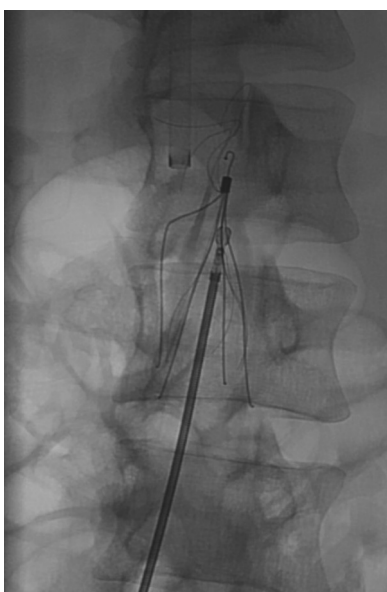


Fig. 3 – Endobronchial forceps repositioning the extraluminal tines inside the IVC lumen. IVC, inferior vena cava.

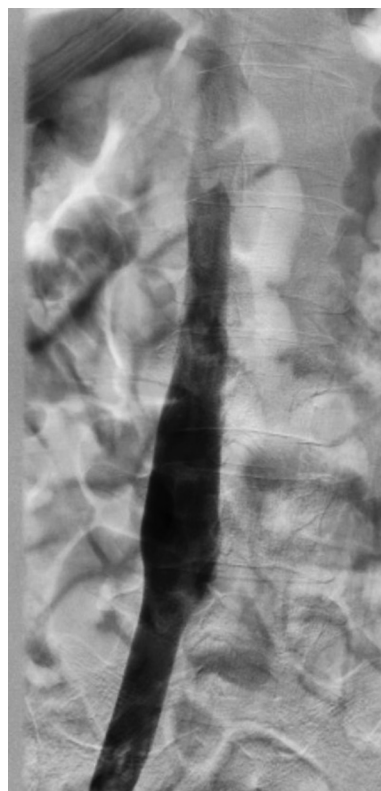


Fig. 4 – Completion venogram showing no IVC wall injury. IVC, inferior vena cava.

hematoma, free air, or any active contrast extravasation. The results were reviewed, and the patient was discharged in good health.

Discussion

Pulmonary embolus and venous thromboembolic disease remains one of the most concerning preventable events in a person's hospital stay. The estimated incidence of pulmonary embolism is 60-70 out of 100,000, with venous thrombosis being as high as 124 out of 100,000 in the general population; with an estimated mortality as high as 30% if left untreated [1]. Pharmacologic prophylactic anticoagulation is the mainstay of treatment for this problem, but there are clinical situations which contraindicate the use of these medications, and thus, it is necessary to consider deployment of an IVC filter. With the advent of temporary and removable filters, it became possible to place these devices during the time of the greatest threat for pulmonary embolism with the plan to remove them when the patient is no longer at an increased risk. Although there are indications for permanent filter placement, the fact is many of the filters that are meant to be temporary end up becoming permanent. One study found that 21.6% of patients had no plan for filter retrieval although they currently had no contraindication to its removal [2]. Although the reasons for this are outside the scope of this discussion, "One of the primary barriers to filter removal is patient follow-up." [3], which was the reason in our patient.

Whether due to lack of contraindications for removal or patients becoming symptomatic, it may become necessary to remove these devices. The usual regulatory threshold for temporary caval filtration retrieval is 30 days, but standard retrieval techniques with catheter, hook, and lasso may be sufficient up to 16 months with a maximal duration reported at 475 days [4]. The longer the device is implanted, the greater the chance of having to use more sophisticated endovascular techniques or even opt for surgical removal. The ease of removal is closely associated with the position of the hook and overall tilt of the filter itself. Over time, these devices tend to settle into the wall of the IVC and gradual tissue fibrosis [5] allows for engulfment of the device and may be the reason for most being asymptomatic but also why there is a possibility for fistula formation [6].

Although IVC filters play a vital role in preventing the morbidity and mortality associated with pulmonary embolism, their placement does not come without complication. These complications include filter movement (0%-18%), filter fracture (2%-10%), recurrent PE (0.5%-6%), access site thrombosis (0%-25%), IVC thrombotic occlusion (2%-30%), and IVC penetration being the highest reported with rates between 0% and 41% [3]. One study, focused just on caval penetration/entrapment, found an overall penetration occurrence of 19% (1699 of 9002) out of which 19% (322 of 1699) of those showed evidence of adjacent organ/structure involvement although the majorities were asymptomatic [7]. Of those patients with organ/structure penetration, the 3 most common involved organs were the aorta, lumbar vertebrae, and duodenum in decreasing order, respectively. Of the patients that were symptomatic, the most frequent symptom was abdominal pain [7] which was also the case in our patient.

When standard retrieval techniques do fail, various advanced endovascular techniques have been attempted. These techniques include the use of various devices such as lasers, forceps, balloons, and different looping techniques. Forceps and lasers have been used for dissection of the fibrosis on the IVC wall to free and grasp the hook [8,9]. In our case, endobronchial forceps were used to manipulate individual tines which provided more filter maneuverability intravascularly and subsequently allowed balloon inflation to free the hook and allow for eventual sheathing of the filter. Our approach allowed for complete removal of the device without any complications and also alleviated the patient's presenting pain. With the majority of caval penetration being asymptomatic, the risk of using endobronchial forceps must be weighed against the possible negative outcome of leaving the filter in place and could explain why advanced techniques are not always performed.

In a case report by Burke et al. [10], a similar endobronchial forceps technique was used to grasp the filter for removal. They inadvertently dislodged 2 of the secondary struts and terminated the procedure do to fear of complication. After a second attempt at retrieval, the filter was successfully removed with minor IVC stenosis noted on follow-up 3 weeks later. They describe the potential for filter damage during endobronchial forceps grasping, leading to filter fracture subsequently resulting in embolization and damage to vascular and cardiac structures [10]. In a single-institution retrospective study, endobronchial forceps were used in the

successful removal of tip-embedded IVC filters in 109 of 114 patients with complications in 4 of the cases including filter fragmentation and IVC pseudo-aneurysm [11]. In a review of 231 cases of advanced filter retrieval techniques, it was found to have complication rates as low as 1.7% and a retrieval rate of 98.2% [12].

A case report describing a filter retrieval after 3 years with aortic and duodenal perforation, endovascular retrieval was successful with discharge on postoperative day 2; this case report included a review of 4 open exploratory laparotomies, performed for similar indications, with a hospital stay ranging from 3 to 21 days with the average being 10 days [13]. Even with our more extensive endovascular technique, our patient was discharged the next day with complete resolution of his pain and without complications. Surgical techniques have been described for use when endovascular retrieval fails and can be performed safely [14,15]; however, they are much more extensive, expensive, and invasive and endovascular techniques should be the mainstay of retrieval when possible.

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