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Total laparoscopic retrieval of inferior vena cava filter

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Abstract

While there is some local variability in the use of inferior vena cava filters and there has been some evolution in the indications for filter placement over time, inferior vena cava filters remain a standard option for pulmonary embolism prophylaxis. Indications are clear in certain subpopulations of patients, particularly those with deep venous thrombosis and absolute contraindications to anticoagulation. There are, however, a variety of reported inferior vena cava filter complications in the short and long term, making retrieval of the filter desirable in most cases. Here, we present the case of a morbidly obese patient complaining of chronic abdominal pain after inferior vena cava filter placement and malposition of the filter with extensive protrusion outside the inferior vena cava. She underwent successful laparoscopic retrieval of her malpositioned inferior vena cava filters after failure of a conventional endovascular approach.

Keywords

Inferior vena cava, inferior vena cava filter, inferior vena cava filter retrieval, laparoscopy

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Introduction

Venous thromboembolism (VTE) is a significant cause of morbidity and mortality affecting nearly one million patients annually in the United States.[1] While systemic anticoagulation is the accepted standard of care, inferior vena cava filters (IVCFs) are indicated when pharmacologic anticoagulation is contraindicated, inadequate, or the specific anatomic location of the thrombus dictates.[2] Unlike permanent IVCFs (pIVCFs), retrievable IVCFs (rIVCFs) allow for filter retrieval once it is no longer needed.[3] Despite their extensive use in current clinical practice, rIVCFs have a comparatively higher incidence of short- and long-term complications including thrombosis, tilt, migration, embolization, caval perforation, and fracture.[4] Filter tilt with erosion of the filter outside the inferior vena cava (IVC) is a troublesome situation that can lead to penetration of the duodenum, aorta, vertebral bodies, or other adjacent retroperitoneal structures. Perforation/penetration of visceral structures can present with abdominal or back pain, with or without an acute abdomen.[5–7] Unfortunately, a tilted IVC filter with the tip embedded in the cava wall can be difficult to retrieve via a standard endovascular approach, since the apex of the filter cannot be easily grasped. While leaving a malpositioned retrievable filter in place as a permanent filter is acceptable in some cases, the clinical situation may dictate more aggressive attempts at filter retrieval to include an open surgical procedure in rare instances.[3] Given the retroperitoneal location of the IVC and necessity for mobilization of the viscera for adequate visualization when utilizing a transabdominal approach for caval exposure and control, this procedure is not without potential for significant morbidity, especially in a morbidly obese patient. Here, we report successful laparoscopic retrieval of a rIVCF penetrating the IVC that presented with abdominal and back pain for several months. To our knowledge, this is the first report of totally laparoscopic IVCF retrieval.

Case report

A 31-year-old morbidly obese female initially presented to an outside hospital in February of 2014 with pulmonary embolism (PE) and iliofemoral deep venous thrombosis

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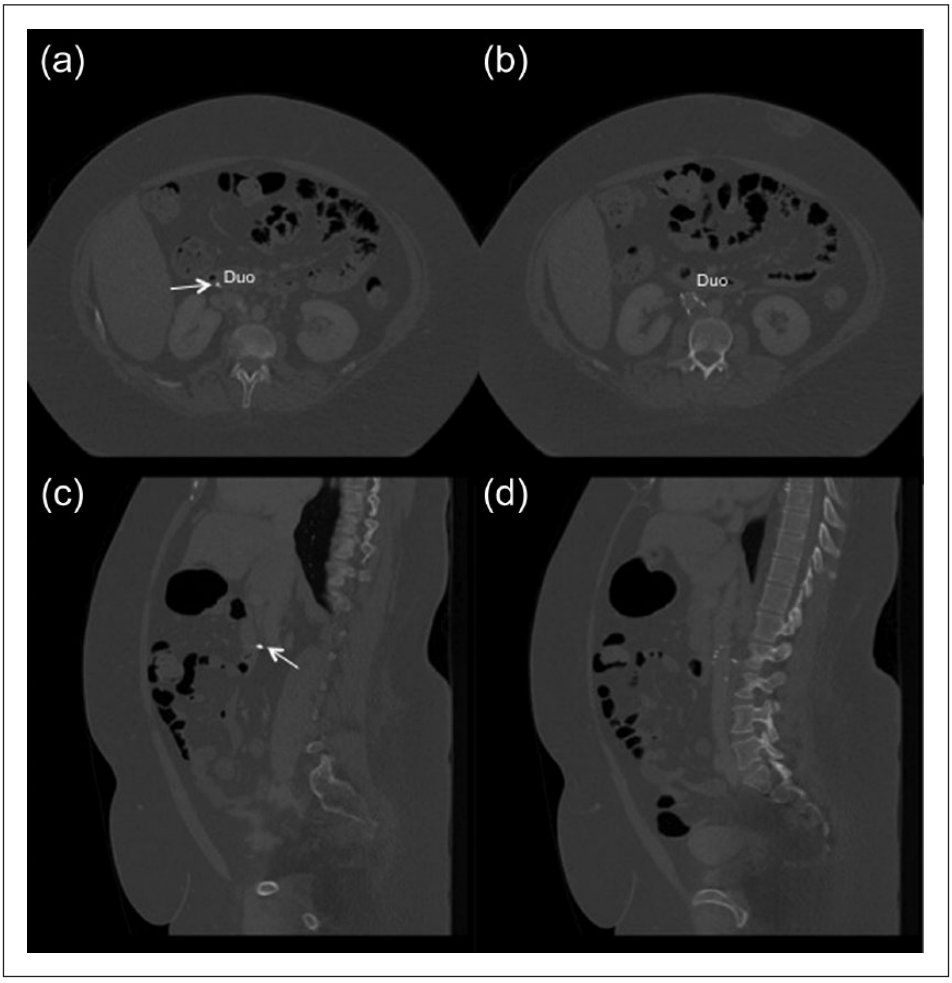

Figure 1. Side by side comparison demonstrating anterior and posterior penetration of vena cava filter tips as seen on computed tomography (a, b) in axial and (c, d) sagittal planes. Filter tip seen penetrating through the cava, abutting the duodenum (white arrow; a, c) and retroperitoneal soft tissue (b, b), presenting as the likely source for the patient's pain. Patient's large body habitus evident from abdominal soft tissue.
Duo = duodenum.

(DVT), which was presumably caused by her body habitus and oral contraceptive use. She subsequently underwent placement of a Cook Celect rIVCF (Bloomington, IN, USA) followed by pharmaco-mechanical thrombolysis of the DVT. Post-lysis, an attempt to extract the filter was made, but it could not be retrieved due to severe tilt. Although the patient complained of new-onset, severe abdominal pain shortly after the attempt at retrieval, it was felt that the filter could not be retrieved due to malposition. The subsequent plan was to anticoagulate the patient with Coumadin and leave the filter in place permanently. She was then transitioned to rivaroxiban (Xarelto) and hematologic workup was negative for inherited thrombophilia.

The patient continued to complain of severe, disabling abdominal pain, and 2 months later, she underwent computed tomography angiography (CTa) which demonstrated severe malpositioning of the device, with orientation at a near-transverse angle and the filter hook protruding beyond the wall of the IVC just caudal and anterior to the right renal vein (Figures 1 and 2(a)). Struts of the filter appeared to be outside the IVC and appeared to be abutting the aorta as well. Given these radiographic findings and persistent abdominal pain requiring narcotics, another retrieval attempt was recommended—likely via an open approach, which the patient declined.

The patient subsequently presented to our institution for a second opinion 4 months after filter placement with persistent pain and was subsequently taken to the angiography suite for a second endovascular retrieval attempt. Venous access was obtained through the right internal jugular and right common femoral veins, and attempts were made to reposition and retrieve the filter. An attempt was made to balloon the filter off the cava wall with very aggressive traction on the filter with a glidewire looped around the apex of the filter. Unfortunately, the filter could not be disengaged from the wall of the vena cava despite multiple attempts.

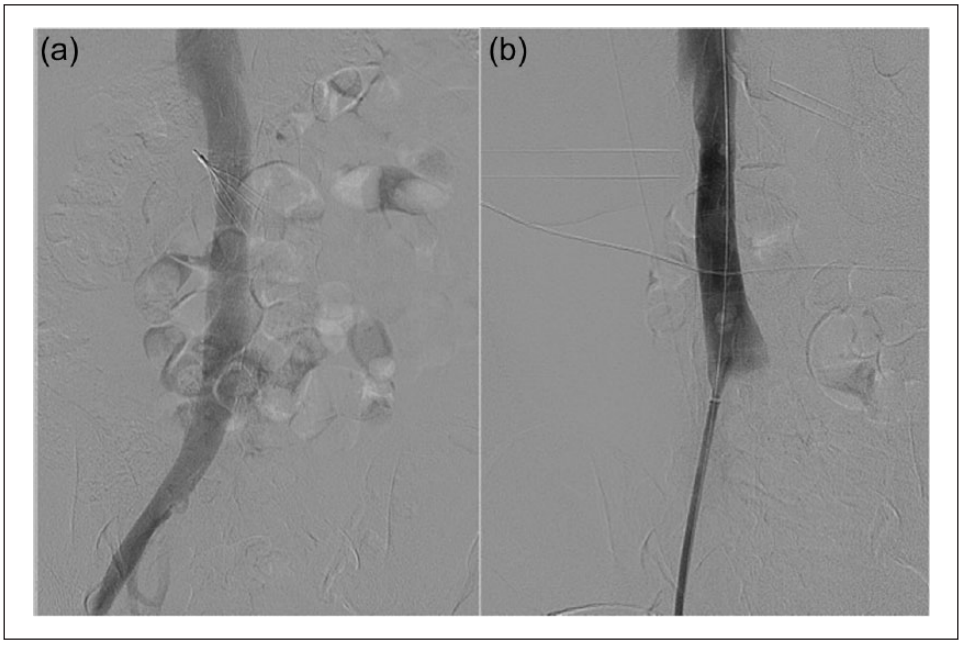

Figure 2. Intraoperative venography at time of laparoscopic-assisted filter retrieval. (a) Evident is the severe angulation with penetration of the head and feet of the inferior vena cava (IVC) filter through the caval wall, with adjacent loops of small bowel and duodenum. (b) Completion venography following laparoscopic-assisted mobilization of duodenum and bowel demonstrating no extravasation from IVC wall following balloon occlusion.

Given the persistent abdominal and back discomfort, the patient still wished to have this device removed. However, given two failed endovascular attempts, a recommendation was made for laparoscopic or open filter retrieval. Three days after the most recent failed attempt at endovascular retrieval, she was taken for a planned laparoscopic or open retrieval. Unfortunately, venogram demonstrated extensive thrombus in the IVC cephalad and caudad to the filter, and filter retrieval was abandoned. Instead, the patient underwent initiation of catheter-directed thrombolysis with placement of the lytic catheter across the thrombosed segment. She remained intubated due to issues with poor respiratory mechanics in the context of her obesity and the need to lie flat for ongoing lysis via a groin sheath. The patient had an otherwise uncomplicated course of lytics, with complete resolution of the IVC thrombus after 24 h, and she was transitioned from heparin to Coumadin.

After a 3-month course of anticoagulation, venogram was again performed which showed no residual thrombus in the IVC (Figure 2(a)), and the patient decided on another attempt at laparoscopic IVC filter retrieval with an open approach if it could not be extracted laparoscopically. During the procedure, the right common femoral vein was accessed with a micropuncture kit and ultrasound guidance by the vascular surgery team, and a 14 French (Fr) sheath was placed so that an occlusion balloon could be rapidly deployed if caval perforation occurred. The general surgery service then achieved peritoneal access via Veress needle (Covidien, Dublin, Ireland) in the left upper quadrant, and the abdomen was insufflated to an intra-abdominal pressure of 17 mmHg due to the excess weight of the abdominal wall, which led to initial difficulty achieving adequate insufflation at a pressure of 15 mmHg; 5-mm laparoscopic ports (Covidien, Dublin, Ireland) were placed in the left upper quadrant, right lower quadrant, left lower quadrant, epigastric, and periumbilical areas. An additional 12-mm port (Covidien) was placed in the right upper quadrant to facilitate filter retrieval, for a total of six laparoscopic ports. Visualization was achieved with a conventional-length 5-mm 30° laparoscope mounted on a Storz high-definition camera (Karl Storz GmbH & Co. KG, Tuttlingen, Germany). We should note that our camera port was rotated throughout the procedure as necessary for adequate visualization. For proper exposure of the IVC, the right colon and duodenum were mobilized laparoscopically. There did not appear to be any free fluid within the peritoneal cavity upon thorough initial laparoscopic inspection. Upon Kocherization, the IVCF tip was seen to be cleanly protruding from the wall of the cava, with a lack of both leakage around the filter tip and local peritoneal reaction. No defect was noted on the duodenum and minimal dissection around the filter hook was required for adequate visualization.

We subsequently used a gooseneck snare passed through the 12-mm port to grasp the top of the filter, and a 12 Fr sheath was passed down over the snare to collapse the filter. The filter subsequently easily disengaged from the wall of the IVC and was pulled up and out of the abdomen along with the 12 Fr sheath. Prior to removal of the filter, a Coda balloon (Cook, Bloomington, IN, USA) had been positioned

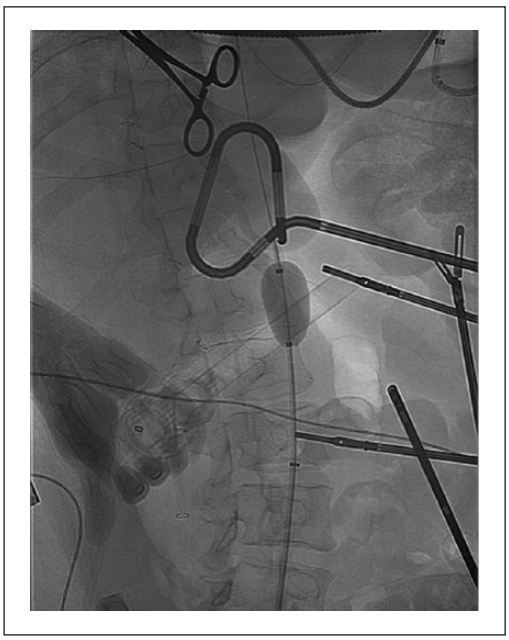

Figure 3. Plain fluoroscopic sagittal view of intraoperative balloon occlusion of inferior vena cava with Coda balloon, demonstrating liver retractor (black arrow), laparoscopic port, and laparoscopic instruments utilized in visceral mobilization.

at and level of the filter, and concomitant with filter extraction was inflated to balloon tamponade any bleeding from the IVC (Figure 3). There was minimal bleeding and after 3 min of balloon inflation and completion venography demonstrated no extravasation (Figure 2(b)). The general surgery team laparoscopically ran the bowel from the ligament of Treitz to the terminal ileum, and there was no evidence of serosal tear or other injury. Wounds were closed primarily, and the patient was extubated at the end of the procedure and subsequently had an uncomplicated hospital course with discharge on postoperative day 1 and no systemic anticoagulation.

She was seen in clinic 2 weeks following her procedure and was noted to have subjective improvement in her abdominal and back pain. The authors would like to note that our institutional review board (DUMC) policy does not require prior ethics approval in the reporting of individual cases, and that written informed consent was obtained relative to the individual whose disease process is herein discussed.

Discussion

Since Food and Drug Administration (FDA) approval in 2003,[8] rIVCFs have been an option for VTE prophylaxis in patients in which anticoagulation is contraindicated. Their use is not without potential problems, however, as rICVFs have been associated with a higher complication rate than traditional pIVCFs. A recent analysis[9] of the FDA's Manufacturer and User Facility Device Experience (MAUDE) database from January 2009–December 2012 demonstrated a total of 1606 adverse events with filter placement, with 86.8% of total complications belonging to the rIVCF subgroup. In terms of frequently reported complications, device fracture (20.8% rIVCF; 1% pIVCF), malposition (13.6% rIVCF; 6.2% pIVCF), caval penetration (13.3% rIVCF; 6.2% pIVCF), migration (10.5% rIVCF; 2.9% pIVCF), and tilt (12.1% rIVCF; 0.2% pIVCF) appear to be the most common. Filter fracture (21.8% of all complications) was observed to be the singular most commonly reported complication,[9] usually presenting in the form of embolus of the foreign body to the pulmonary artery or ventricular chambers, resulting in PE or tamponade, respectively. Malposition or migration of the filter may diminish the efficacy of the device. Filter tilt allows passage of thromboemboli through the struts, rendering the filter less effective and predisposing to caval penetration, which occurs in 2%–29% of cases depending on filter type.[10–12] While caval penetration is often identified as an incidental finding on imaging, it can cause serious complications including acute or chronic pain, hemodynamic instability, bowel perforation, and pancreatitis.[5,7,11,13–17] In our patient, persistent abdominal and back pain raised clinical suspicion for filter migration and extension outside the cava wall. CT and fluoroscopic imaging revealed nearly 90° filter tilt and extension of the filter apex through the wall of the cava with abutment of the duodenum, with the barbed filter prongs penetrating the caval wall, abutting retroperitoneal soft tissue structures and the aorta.

With the exception of one case report of endovascular retrieval, duodenal penetration by rIVCFs is typically managed by laparotomy, with techniques developed to minimize size of the cavotomy.[5,18] Endovascular retrieval had failed several times in our patient, due to penetration of the filter tip well beyond the cava wall. With the patient's morbid obesity (body mass index (BMI) > 50), open repair would be challenging and would have potential serious morbidity from a cardiopulmonary and wound standpoint. Of note, the successful use of laparoscopy was first described by Proctor et al.[19] in 1998 to assess IVCF penetration in an ovine model (although this was limited to assessment of the infrarenal portion of the IVC) with subsequent successful endovascular IVCF removal under laparoscopic purview (also an ovine model) described by Laborda et al.[20] more recently. However, no cases in the literature describe successful laparoscopic filter retrieval in humans.

In this instance, the patient was uniquely suited to a total laparoscopic approach because the top of the filter and the retrieval hook were well outside the IVC and protruding anteriorly. A relatively straightforward laparoscopic mobilization of the duodenum from the IVC exposed the IVC filter and allowed successful endovascular retrieval after the hook of the filter was disengaged from the duodenal serosa through gentle manipulation with non-traumatic laparoscopic graspers. Although perforation of the duodenum was not demonstrated, filter adherence to the serosa of the duodenum may

have been responsible for her persistent pain.[5] Certainly, intraoperative upper esophagogastroduodenoscopy (EGD) has been utilized as an adjunctive diagnostic maneuver in prior reports of filter penetration through the duodenum, oftentimes visualizing a prong of the filter penetrating through the wall of the duodenum into the lumen itself.[5,15,16,21] We opted not to perform this maneuver as there was good duodenal visualization with the laparoscope after Kocherization.

We would be remiss to omit the discussion of our utilization of increased pneumoperitoneum (17 mmHg), which was originally utilized as the patient had excess weight on her anterior abdominal wall, preventing adequate initial insufflation at lower pressures. Prior authors have reported the utilization of higher pressures to control bleeding, although this seems to be limited to scant venous oozing and non-vascular surgery.[22] The inadvertent utilization of increased pneumoperitoneum in concert with Coda balloon occlusion of the cava is a useful technique to employ in attaining adequate hemostasis from such large vascular structures, and this joint endoluminal and endoscopic vascular control technique is one which the surgeon should keep in mind if attempting to perform totally laparoscopic filter retrieval.

As the indications for IVCF placement expand, the number of cases with tilt and subsequent perforation may increase substantially.[15] Retrieval of most, if not all, IVC filters has been recommended by many authors to prevent the development of late complications.[23,24] In addition, to allay fears over the potentially devastating consequences of filter malpositioning, emerging endovascular techniques to reduce tilt have been described.[25]

Filter tilt is a serious complication with a varying clinical presentation. We describe a young morbidly obese woman with caval penetration presenting with persistent abdominal and back pain after rIVCF placement. Given her imaging findings, it is suspected that the prongs of the filter were adherent to her viscera without penetrating deeper than the serosa. Despite being referred for a possible open procedure, potential for major morbidity was high given her BMI. She was adamant that she wished to avoid an open procedure for filter retrieval, which we have described as being technically feasible through a totally laparoscopic means, which has to this point only been described as technically feasible in an ovine model.

It is important to keep in mind that only a small subset of patients with malpositioned filters would be candidates for laparoscopic retrieval, and we remain strong advocates of an endovascular first approach to filter retrieval. This patient had the filter tip protruding well outside the cava wall and in a location that could be accessed by a relatively straightforward laparoscopic approach. Patients with the filter tip protruding posteriorly or to the left of the IVC would be less suitable for this approach, and patients with the filter tip embedded in the cava wall but not actually outside the cava would also be more challenging. The major downside of this laparoscopic approach is the potential for significant blood loss or CO_2 embolism if the cava were to tear significantly during filter extraction. In a morbidly obese patient, it is neither necessarily quick nor straightforward to open the abdomen and control the injured cava. For this reason, we had obtained very large-bore sheath access to the cava so that an occlusion balloon could be placed if needed. Placement of a hand port would be another option so that direct pressure could be held to slow down any bleeding. In any case, it is critical that the surgical team is prepared for immediate conversion to an open procedure, and that the anesthesia team is ready for massive fluid resuscitation and transfusion.

Likewise, vigilance on behalf of the surgical and anesthesia providers in the case of CO_2 embolism should be maintained in the setting of a caval tear, with patients presenting with decreases in end-tidal CO_2, hemodynamic derangement, arrhythmias, and cyanosis.[26] It is accepted that this condition is diagnosed with the aforementioned physiologic and clinical parameters along with transesophageal echocardiography,[27] and subsequently managed by immediate desufflation of pneumoperitoneum, serial arterial blood gases, Trendelenburg and left lateral decubitus positioning, and use of 100% oxygen. Our initial placement of a Coda balloon could ameliorate any CO_2 absorbed into the cava during a large tear, although it should be noted that the bloodstream rapidly metabolizes CO_2, resulting in acidosis. Otherwise, CO_2 embolism can be avoided by careful laparoscopic techniques and dissection around the cava and other major vascular structures. In the case of hard signs of gas embolism, the patient should be monitored postoperatively in the intensive care unit setting.

While endovascular IVC filter retrieval is preferable in the vast majority of cases, in some clinical scenarios, a filter may be malpositioned such that engaging the filter tip with a snare is impossible despite the most aggressive intraluminal maneuvers. Leaving a malpositioned filter in place is always an option, but in rare cases may represent an unacceptable risk. Open surgical filter extraction can certainly be performed safely, but is likely to be relatively morbid, especially in patients with morbid obesity or other relative contraindications to a major abdominal operation. Laparoscopic IVCF retrieval may be a reasonable option for the subset of patients with a filter tip that is outside the cava and can be exposed with laparoscopic mobilization. To limit the risk of catastrophic caval injury and uncontrolled bleeding, we recommend a team approach with an experienced laparoscopist performing the exposure and a vascular surgeon who is comfortable with both endovascular filter retrieval and rapid open control of a caval injury.

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