Symptomatic inferior vena cava perforation by a retrievable filter: Report of two cases and a literature review

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Inferior vena cava filters have been used frequently for decades to prevent pulmonary embolism in medical, surgical and trauma patients. With the advent of temporary or retrievable filters, the use of these filters has increased substantially. However, the enhanced design and attributes that make these devices attractive for short-term benefit and retrieval are not without risk. Two cases of symptomatic inferior vena cava wall penetration are reported – one of which required surgical intervention.

Key Words: *Inferior vena cava filter; Inferior vena cava filter complications; Inferior vena cava wall penetration; Retrievable filter*

The concept of inferior vena cava (IVC) interruption to prevent pulmonary embolism (PE) is not new. The Mobin-Uddin filter in 1967 was the first intravascular device designed (1). However, due to a high incidence of thrombosis and occlusion of the original device, the Kimray-Greenfield filter quickly became the preferred choice (1). Since then, a number of filters have been created with the goals of improving ease of insertion and placement, optimizing function and decreasing complications (2-4).

Indications for IVC filter placement include contraindications to anticoagulation, complications secondary to anticoagulation, inability to achieve adequate anticoagulation, and failure of anticoagulation in those patients with or at risk for venous thromboembolism. Although the indications for filter placement continue to be debated, relative indications include noncompliance with therapy, occult bleeding and prophylaxis in high-risk patients (5). Indications can be further divided into preventive and prophylactic categories. Preventive indications include proven venous thromboembolic disease (placing the patient at risk for embolism) and documented PE. Prophylactic indications include no documented deep venous thrombosis (DVT) or PE, but the likelihood of increased risk (2). Knudson et al (6) reviewed more than 1600 trauma patients and found that 79% of filter placements were performed for prophylaxis rather than therapeutic purposes. Furthermore, a review of the National Trauma Databank (2,7) showed that 86% of filters were placed for prophylaxis, with 12% placed in patients with no thromboembolic risk factors. Trauma patients remain at a risk as high as 50% for development of DVT, and as high as 32% for PE (7). According to the 2002 Eastern Association for the Surgery of Trauma guidelines, placement of an IVC filter in these patients remains a level III recommendation (2).

The newest concept is the retrievable or temporary filter designed to be removed easily after the acute indication for placement has resolved, thereby providing short-term benefit and avoiding the long-term complications of a permanent filter. However, few of these are reportedly retrieved and the incidence of long-term complications is unknown (3,4,8). Recommendations regarding placement, patient follow-up and guidelines for retrieval need to be assessed.

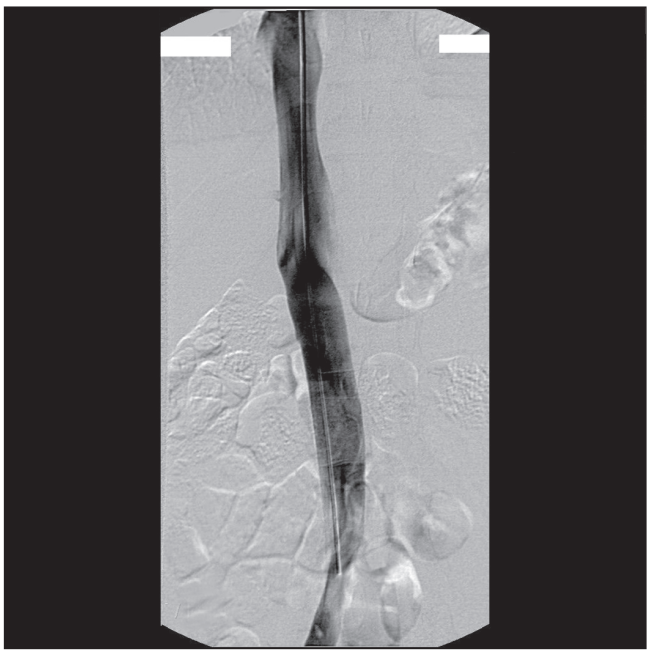

Figure 1) *Venogram after Celect inferior vena cava filter (Cook Medical, USA) placement*

CASE PRESENTATIONS

Case 1

A 27-year-old man presented to the emergency department with complaints of intermittent abdominal and back pain following placement of an IVC filter approximately 10 months earlier (Figure 1). He described new complaints of nausea and vomiting with streaks of blood, and increasing epigastric pain worsened by eating and changes in position. Initially, he had presented after sustaining a gunshot wound to the right leg and subsequently developing DVT of the femoral and popliteal veins. Due to

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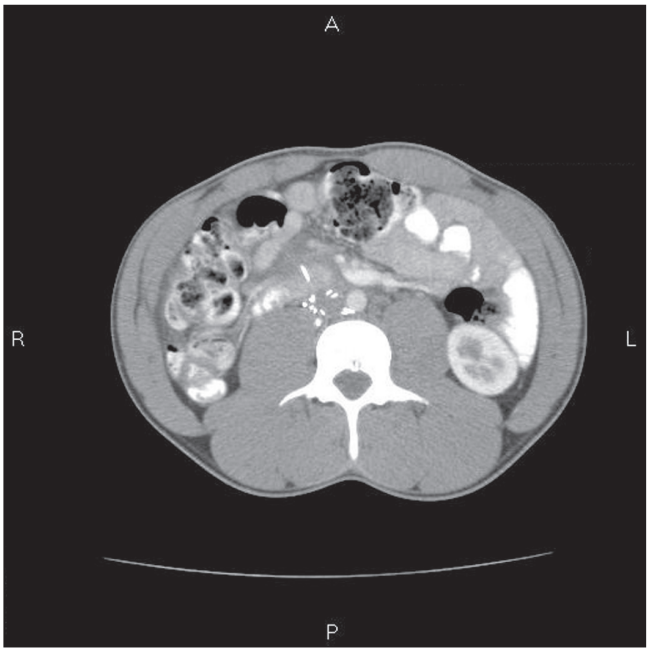

Figure 2) *Duodenal and inferior vena cava perforation after Celect filter (Cook Medical, USA) placement*

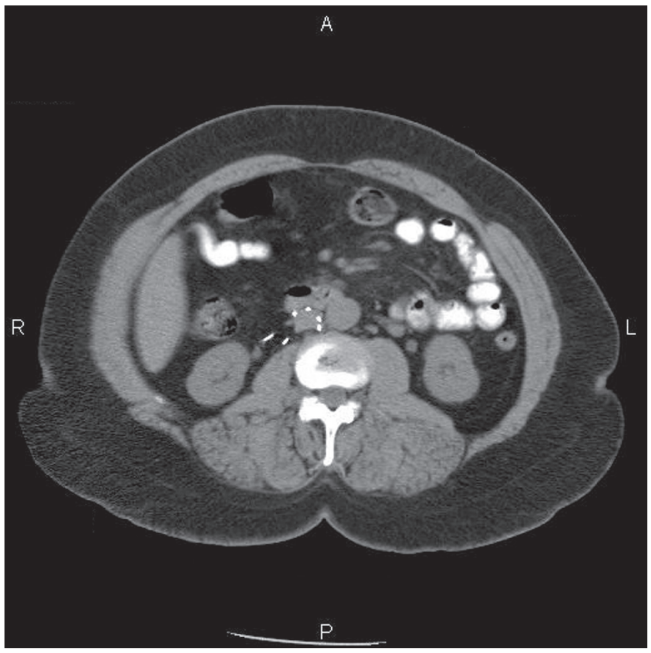

Figure 3) *Inferior vena cava perforation after G2 filter (Bard Peripheral Vascular, USA) placement*

noncompliance with anticoagulation therapy (warfarin), the patient underwent placement of a Celect IVC filter (Cook Medical, USA). Following discharge, the patient experienced persistent abdominal pain. A computed tomography (CT) scan showed a perforation of the IVC by one of the filter's prongs 2.5 cm into the duodenum (ie, a duodenocaval fistula) (Figure 2).

On presentation, his vital signs were stable and examination was positive for diffuse mild abdominal tenderness without rebound, guarding or other peritoneal signs.

The patient was taken to the operating room for exploratory laparotomy. An extensive Kocher manoeuvre was performed. An area adjacent to the duodenum was firm and hard with extensive scar tissue. The IVC was dissected free, revealing the filter prong protruding from the vena cava completely traversing the posterior to the anterior duodenum, where the inflammatory tissue was seen, clearly identifying the duodenocaval fistula. A purse string suture was placed around the IVC puncture site and the prong was divided with wire cutters. The duodenum was repaired primarily with Vicryl (Ethicon Inc, USA) and silk sutures in a Lembert fashion. Further inspection of the anterior duodenum revealed chronic inflammation in the mesentery, which was dissected free of the duodenum. No purulent or bilious material was present. The duodenal repair was tested with methylene blue via the nasogastric tube without signs of extravasation. An omental flap was then freed from the transverse colon and placed between the duodenum and IVC. The abdomen was then closed in the usual fashion. Postoperatively, the patient's hospital course was unremarkable and he was discharged on postoperative day 7.

Case 2

A 61-year-old woman presented to the emergency department with complaints of nausea, shortness of breath, chronic intermittent chest pain and right-sided abdominal pain. Her medical history included coronary artery disease, congestive heart failure, hypertension, diabetes and a left renal vein thrombosis for which she was taking warfarin. Approximately four years earlier, the patient received a suprarenal G2 retrievable IVC filter (Bard Peripheral Vascular, USA) for the left renal vein thrombus. A CT scan demonstrated right ureterolithiasis and revealed the filter at the level of the left renal vein. The patient returned two weeks later and a repeat CT scan verified no change in the filter's appearance. The patient presented again six months later with similar abdominal complaints. Repeat CT imaging identified several of the prongs penetrating the IVC wall with no other intra-abdominal pathology. Vascular surgery was consulted. The patient's evaluation was otherwise negative, the acute symptoms resolved, and she was discharged with no surgical intervention required. Therefore, the filter was not removed secondary to risk of IVC perforation. Approximately one year later, a repeat CT scan confirmed stability of the filter, with several prongs extending outside the IVC but no noted acute process (Figure 3).

DISCUSSION

Since 2003, when the retrievable filter was first approved by the United States Food and Drug Administration, there has been a substantial increase in its popularity. Ease of insertion, better control in accurate placement, increased reliability and potential ease of removal make the retrievable device a theoretically superior option for providing short-term benefits and avoiding long-term risk. The importance of temporary filters was demonstrated in the only prospective randomized trial, in which Decousus et al (9) analyzed the benefit of IVC filters in patients with documented DVT and no contraindications to anticoagulation. There was a significant decrease in early PE within the first 12 days in the filter group (1.1% versus 4.8%) but a significant increase in DVT at long-term follow-up with no change in mortality. However, filters are reportedly rarely retrieved. Antevil et al (10) reported a threefold increase in IVC filter use after the introduction of the retrievable filter, with only 21% removed. In a large American Association for

the Surgery of Trauma multicentre trial in 21 centres (3), 79% of all filters placed were retrievable, 22% were retrieved, and only one-half of the patients had follow-up after discharge.

Gaspard and Gaspard (8) reviewed the records of 310 patients over a two-year period and found that 298 patients received retrievable devices, but only 11 devices (3.7%) were successfully removed. In addition, one reviewed patient from a separate facility experienced filter migration and erosion into a lumbar artery, while another had right atrium perforation during placement. Gaspard and Gaspard (8) found an overall 2.6% long-term complication rate, which included IVC thrombosis, inner caval wall trauma with erosion, filter tilt and bleeding. Other authors have reported the incidence of thrombotic complications such as DVT to be as high as 46%, the incidence of postphlebitic syndromes as high as 41% and the incidence of IVC thrombosis up to 11% for nonretrievable IVC filters (2). For retrievable filters, the incidence of IVC thrombosis has been reported to be between 6% and 30%, filter migration between 3% and 69%, and postphlebitic syndrome between 5% and 70% (4).

Clinically meaningful filter migration is defined as cranial or caudal migration of greater than 1 cm. Migration may occur in as many as 5% of cases, with only 0.4% being clinically important, while malpositioning at the time of insertion occurs in 2% of procedures (11). It is unknown whether malpostitioning or migration is a progression of events or a risk factor for subsequent penetration and perforation leading to symptoms. Filter penetration is defined as an extension of the filter components of greater than 3 mm outside the caval wall. Sadaf et al (12) described two types of penetration – true penetration, in which the filter struts penetrate through the IVC, and pseudopenetration, in which the struts are buried in the wall as a result of myointimal remodelling without actually protruding outside the vena cava. In theory, pseudopenetrations are asymptomatic, can be differentiated on CT scans and may account for the majority of reported penetration cases (12).

Transmural penetration of the vena cava has been reported in injuries to the duodenum, aorta, portal vein, small and large intestine, pancreas, kidney, renal vein, spinal column, diaphragm, genitourinary system and the retroperitoneum (4,5,10,12,13). The overall incidence of caval penetration is difficult to assess. On imaging, up to 25% of filters erode through the caval wall (13). Streiff (14) reported strut penetration in 37.9% of patients after placement of a bird's nest filter, while the Greenfield filter has a reported strut penetration rate of 3.5%. Large series (5) report that approximately 10% of these perforations are symptomatic and may require intervention.

Our first patient received a Celect retrievable IVC filter. The filter was designed to have higher successful retrieval rates and longer indwell times. The Celect filter has secondary struts, which are separate and independent from the primary struts – the arrangement of which was designed to enable retrieval even if the wires were incorporated into the caval wall (15). However, this change in design may have increased its propensity for migration and penetration (12). Sangwaiya et al (16) reviewed 73 patients with Celect filters and found that four (5.5%) had immediate substantial tilt. At 62-day follow-up, 47 filters showed no signs of migration; however, follow-up CT scan showed that seven patients (14.9%) had filter-related complications, including strut penetration in four patients and fractures with component migration in one patient. They concluded that the filter can be safely placed but has a high incidence of caval penetration. Charles et al (17) reviewed 115 patients and found that 57 filters (49.6%) were retrieved successfully at an average of 114 days, with penetration occurring in only two cases.

Our second patient received a G2 retrievable filter. The G2 is the second generation of the Recovery filter (Bard Peripheral Vascular, USA). The Recovery filter was voluntarily withdrawn in 2005 and the G2 was designed to provide greater resistance to migration, improve filter centering, allow extended retrieval times and enhance resistance to fracture (17,18). Charles et al (17) reviewed 140 patients with G2 filters and found that only 26 met criteria for removal; however, there was a 100% successful retrieval rate. No substantial filter migration was noted in any patient; however, five filters (19.2%) had notable tilt of greater than 15°, with four others demonstrating tilt progression on follow-up imaging. Cantwell et al (18) retrieved 55% of the filters at 230 days with no filter fractures; caudal migration occurred in only 4%. However, they noted that imaging was not available in the majority of cases without attempted filter retrieval. Charles et al (17) emphasized that venography, commonly used in placement, retrieval and follow-up, may not be sufficient to confirm the projection or penetration of the struts because some may appear to be simply indenting the IVC wall to varying degrees. They suggested that CT imaging may be more effective in determining caval wall penetration. In their study, they did not attempt to determine or report the incidence of filter penetration due to this drawback of venography (17).

Despite decades of experience with the use of vena cava filters and the introduction of retrievable or temporary filters, there is still a relative paucity of literature regarding the appropriate tracking of patients and recommendations for adequate follow-up. The 2006 Vena Cava Filter Consensus Conference (19) recommended obtaining objective radiological testing, including abdominal radiographs, to determine placement stability, duplex examination of the lower extremities to identify recurrent DVT or chronic venous insufficiency, and scanning to identify extracaval filter extension and caval thrombosis. Charles et al (17) reported that only 26 of 140 patients met criteria for retrieval, as determined by sending a letter to the referring physician at three months and another at six months after filter placement. Cantwell et al (18) contacted the referring physician or patient at six-month intervals and the recommendation for filter retrieval was made if the patient's risk for embolism had returned to baseline or if full anticoagulation had been obtained. If the retrieval attempt failed, the patient had an indication for lifelong placement, the referring physician or patient could not be contacted after three attempts, or if prophylaxis was still needed after follow-up, then the filter was deemed to be permanent. Fifty-five per cent of filters were retrieved and only 10% of the patients were lost to follow-up. In an American Association for the Surgery of Trauma multicentre trial reviewing retrievable filters, institutions in which the service that places the filter is primarily responsible for follow-up had higher rates of filter retrieval (18). Martin and Salim (2) recommend consideration of chemical prophylaxis after an initial observation period with no signs of ongoing

TABLE 1
Recommended guidelines for filter removal from the 2006 Vena Cava Filter Consensus Conference

The patient does not have an indication for a permanent filter.
The risk of clinically significant PE is acceptably low due to sustained primary treatment (therapy or prophylaxis) or a change in clinical status. Patients should demonstrate the ability to tolerate and sustain primary treatment.
The patient will not return to a high risk for PE in the near future due to interruption of anticoagulant treatment for surgery, change in clinical management or change in clinical condition.
The life expectancy of the patient is such that the potential benefits of discontinuation of filtration can be realized. Patients who are not anticipated to survive beyond six months are unlikely to have any discernible benefit from filter retrieval or conversion.
The filter can be safely retrieved. Filters that, in the judgment of the physician performing the discontinuation procedure, cannot be safely retrieved without causing unacceptable injury to the patient should not be manipulated.
The patient or consenting guardian agrees to have the filter removed. Patients who prefer to keep their filters in place should be allowed to do so.

PE Pulmonary embolism. Data from reference 19

hemorrhage rather than proceeding directly to prophylactic vena cava filter placement. Table 1 shows the recommended guidelines for filter removal from the 2006 Vena Cava Filter Consensus Conference (19). The authors of the guidelines recommend bilateral lower extremity venous ultrasound examination to rule out DVT before filter removal.

Despite some of its shortcomings, the retrievable or temporary filter is still a reasonable therapeutic option. In the short term, the Celect and G2 filters are associated with very low rates of thrombosis and symptomatic PE, a moderate retrieval success rate and a good retrieval safety profile (17). The G2 filter has also been shown to have less filter fracture and tilt, and greater successful placement, although at an increased incidence of caudal migration (18). The complications of leaving a temporary device in place over the long term are currently unknown. Improved patient tracking, further guidelines for candidates for filter removal, and development of short- and long-term follow-up protocols are needed, and should be continually modified and addressed to avoid potential long-term complications of these temporary devices.

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