Duodenocaval Fistula from an Inferior Vena Cava Filter Perforation

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Background: This article describes a rare case of inferior vena cava (IVC) filter perforation into the duodenum in a patient presenting with abdominal pain.

Case report: A 55 year old woman presented with abdominal pain four years after an IVC filter placement. Workup demonstrated an IVC filter strut perforating the duodenum. The filter was removed via laparotomy, the duodenum was closed primarily, and the IVC was repaired. The patient was discharged home on post-operative day five and is doing well.

Conclusions: Most extraluminal perforations of IVC filter struts are asymptomatic. Rare filter associated duodenal perforations may present with non-specific abdominal symptoms. If no other diagnosis can be attributed to the patient’s presentation, direct removal of the filter and repair of the duodenum are indicated.

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INTRODUCTION

Inferior vena cava (IVC) filters are indicated in patients at high risk of venous thromboembolism (VTE) when anticoagulation is contraindicated or fails. While guidelines are clear on the indications, IVC filters are increasingly used as prophylaxis in patients with fall risk, bariatric and trauma patients, and patients with VTE. Although significant improvements in the last decade in the design of retrievable filters have led to an increased use of filters, the actual removal rate is less than 25%. Overall, filter placement is considered to be a safe procedure; however, there is clear evidence that the insertion of filters may cause complications years after their placement. The most commonly described complications include access site complications, IVC filter migration, strut fracture, and IVC occlusion.1–3

A case of IVC filter strut perforation into the duodenum, causing severe dyspeptic symptoms and abdominal pain, is presented.

CASE REPORT

A 55 year old woman with a history of peripheral arterial disease, chronic obstructive pulmonary disease, coronary artery disease, gastroesophageal reflux disease, hepatitis C, rheumatoid arthritis, appendectomy, and aortobi-iliac bypass graft for disabling short distance claudication presented with several weeks’ history of severe intermittent right upper quadrant pain, poor appetite, nausea, and emesis. She had a history of IVC filter placement four years prior to presentation for deep vein thrombosis at another hospital. The patient was on high dose proton pump inhibitor therapy prior to admission. The laboratory workup was unremarkable. Imaging workup demonstrated perforation of the IVC filter strut into the third part of the duodenum (Fig. 1A) and a dilated 9 mm common bile duct with an ampullary stricture. Esophagogastroduodenoscopy (EGD) revealed an IVC filter strut protruding into the third part of the duodenum with mucosal ulceration and thickening (Fig. 1B). Endoscopic ultrasound (EUS) and endoscopic retrograde cholangiopancreatography with brushings were performed to evaluate the ampullary stricture, followed by sphincterotomy and placement of a biliary stent. EUS was negative for a mass and cytology findings were benign.

Despite an extensive workup, the patient remained symptomatic with persistent abdominal pain and poor oral intake with no other identifiable causes, at which point retrieval was planned. A cavagram was performed, which demonstrated a patent IVC with the struts of the filter outside the lumen (Fig. 1C). Open surgical removal of the IVC filter with a duodenal repair was planned owing to the prolonged dwell time. Endovascular removal of the filter was not considered owing to potential complications of IVC rupture and duodenal injury.

The operation was performed through a right transverse incision. A Cattell—Braasch manoeuvre was performed to expose the IVC from the renal vein confluence to the IVC bifurcation. Individual lumbar veins were clipped or
controlled with silastic vessel loops. One of the struts was encased in a dense peri-ureteric tissue but was not penetrating the lumen of the right ureter. The strut was cut with wire cutters and pulled out. Next, the duodenocaval fistula (Fig. 2A) was completely exposed. The patient was heparinized and the IVC was occluded with the Rummel tourniquets. The IVC was opened through a longitudinal venotomy and the strut penetrating the duodenum was gently pulled out. The fistula was completely transected, and the duodenum was closed in two layers, and the area copiously irrigated with saline (Fig. 2B). The luminal segments of the filter legs, which were encased in dense fibro-intima, were sharply dissected out and the entire filter removed (Fig. 2C). To avoid narrowing, the IVC was repaired with a greater saphenous vein patch angioplasty (Fig. 2D and E). The patient recovered uneventfully and was discharged home on post-operative day five. She was doing well on her follow up visit six months after surgery, with complete resolution of abdominal pain and dyspepsia.

**DISCUSSION**

IVC filters have been used increasingly since the early 1970s for the prevention of VTE disease in patients that are unable to undergo systemic anticoagulation. With the introduction of retrievable IVC filters, there has been an increased use of these devices in prophylactic settings, despite lack of evidence and low retrieval rate. Due to lack of randomized data, there is no one filter that provides an improved safety profile over any other. Some of the more commonly reported complications of IVC filters include recurrent pulmonary embolism in 0.5%–6%, filter migration in 0%–11.8%, caval thrombosis in 2.7%–13%, filter fracture in 23%–40%, and IVC perforation in 15%–70%. These complications can be seen as early as six months after implantation, and the rates are probably quite conservative due to underreporting, lack of routine surveillance, failure of diagnosis, and most complications being asymptomatic. As such, elective retrieval is indicated when filters are no longer needed. It is common to attempt to retrieve the filters within six months of their placement as attempts after one year often fail due to the fibro-intimal incorporation of the struts and hooks of the filter into the IVC wall.

Duodenal perforation from an IVC filter strut perforation is a rare complication, whose true incidence is unknown. The majority of the patients with symptomatic duodenal perforations present with epigastric and right upper quadrant abdominal pain radiating to the back. As the pain is often non-specific, pain caused by an IVC filter is a diagnosis of exclusion. Pain can also be accompanied by dyspepsia and poor gastrointestinal (GI) tolerance. A high index of suspicion is also recommended for patients with a history of IVC filter placement presenting with a GI bleed.

The initial workup to identify the filter as the source of pain or GI bleed includes radiographs, followed by computed tomography and EGD. An upper GI series and adjunctive imaging studies are useful to rule out gastric outlet, small bowel, or biliary obstruction. A cavagram is often used to identify the patency of the IVC and evaluate for potential clot burden. As there are no formal guidelines on the removal of symptomatic late complications of IVC filters, the decision should consider the severity of the symptoms, risk vs. benefit, and the ability to rule out other potential etiologies of the patient’s presentation.
| Author (year)* | Age, sex | Clinical presentation | Interval from placement and diagnostic modality | Indications | Type of IVC filter and treatment modality | Complications and outcomes |
|---------------|----------|------------------------|-------------------------------------------------|-------------|----------------------------------------|--------------------------|
| Irvin (1972)  | 48, M    | Fever, RUQ pain + right flank tenderness | 7 days; AXR | Recurrent PE despite AC | Mobin-Uddin; ligation of the IVC just below renal veins | No complications; resolution of symptoms |
| Appleberg et al. (1990) | 71, F | Diarrhoea + weight loss | 6 y; AXR + EGD + cavagram + CT of the abdomen/pelvis | Massive iliofemoral DVT | Greenfield; repair of the duodenum and extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Taheri et al. (1992) | 41, F | CP + SOB + RUQ pain | 7 mo; AXR + cavagram | DVT + PE + GI bleed | Greenfield (suprarenal); repair of the duodenum and extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Tritsch et al. (1993) | 66, F | Fever + weight loss + epigastric pain | 4 y; AXR + EGD + CT of the abdomen/pelvis | DVT + PE | Kimray—Greenfield; strut cut flush with the IVC + repair of the duodenum (no cavotomy) | Small bowel obstruction; CVA during hospitalisation and death |
| Goldman et al. (1994) | 58, F | RUQ abdominal + flank pain | 10 y; EGD + BE + colonoscopy + abdominal US + cavagram + CT of the abdomen/pelvis | Intracranial bleed + DVT | Mobin—Uddin; extraction of filter found outside the IVC | No complications; resolution of symptoms |
| Al Zaharani et al. (1995) | 55, M | Melaena + haematemesis | 5 y; EGD + CT of the + abdomen/pelvis | Recurrent DVT + PE despite AC | Bird’s nest; strut cut flush with the IVC repair of the duodenum (no cavotomy) | Post-operative DVT requiring AC; resolution of symptoms |
| Bianchini et al. (1996) | 29, M | Heartburn + haematemesis | 16 mo; AXR + EGD | DVT + PE despite full AC | Greenfield; repair of the duodenum + partial extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Sarkar et al. (1997) | 68, F | Anaemia + GI bleed | 11 y; EGD | DVT + PE post-operatively | Mobin—Uddin; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Dardik et al. (1997) | 36, M | Nausea (SB obstruction) | 2 y; AXR + UGI series +EGD + CT | DVT + GI bleed | Greenfield; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Authors           | Age, Sex | Symptoms                          | Duration | Imaging & Procedure                          | Complications                                                                 |
|-------------------|----------|-----------------------------------|----------|---------------------------------------------|-------------------------------------------------------------------------------|
| Guillem et al.    | 60, F    | Abdominal + lumbar pain           | 10 y     | Abdominal US + EGD + CT of the abdomen/pelvis | Thrombophlebitis + recurrent PE Thrombectomy + repair of the duodenum + extraction of the filter (cavotomy) Thrombectomy + repair of the duodenum + extraction of the filter (cavotomy) Post-operative bleeding requiring ligation of a disrupted IVC branch; resolution of symptoms long term |
| Feezor et al.     | 40, M    | Epigastric/RUQ pain + weight loss | NR; plain AXR + abdominal US + CT + EGD + cavogram | DVT + stroke Bird's nest; strut cut flush with the IVC + repair of the duodenum (no cavotomy) No complications; resolution of symptoms |
| Formentini et al. | 23, F    | Epigastric pain                   | 5 y      | AXR + EGD + CT of the abdomen/pelvis        | Post-partum DVT + PE NR; repair of the duodenum extraction of the filter (cavotomy) No complications; resolution of symptoms |
| Mansour et al.    | 41, M    | Haematochezia + abdominal pain    | 4 y      | UGI series + EGD + CT of the abdomen/pelvis | PE + GI bleed Bird's nest; strut cut flush with the IVC + repair of the duodenum (no cavotomy) No complications; resolution of symptoms |
| Durairaj et al.   | 83, F    | Epigastric discomfort             | 6 y      | abdominal US + CT of the abdomen/pelvis + ERCP | Recurrent DVT + stroke + epistaxis/haematuria Greenfield; non-operative management, long term antibiotic therapy NR long term; resolution of symptoms for one mo |
| Botsios et al.    | 77, F    | Epigastric pain + GI bleed        | 9 y      | EGD + CT of the abdomen/pelvis             | DVT + massive PE Greenfield; repair of the duodenum extraction of the filter (cavotomy) No complications; resolution of symptoms |
| Ibele et al.      | 48, F    | RUQ pain                          | 14 mo    | CT of the abdomen/pelvis                    | Severe trauma + retroperitoneal bleed Recovery; endovascular retrieval No complications; resolution of symptoms |
| Veroux et al.     | 46, F    | Diffuse oedema left lower extremity + mural thrombus in the aorta and IVC occlusion | 2 y | DUS of the lower extremity + CT of the chest/abdomen/pelvis | Recurrent DVT + PE despite full AC Recovery; repair of the duodenum + extraction of the filter (cavotomy) + aortic thrombectomy No complications; residual IVC thrombus |
| Parkin et al.     | 21, M    | Lower back pain + discitis        | 5 y      | CT of the abdomen/pelvis                    | DVT + multiple PE despite AC Günther tulip; extraction of the filter (cavotomy) No complications; resolution of symptoms |
| Franz et al.      | 27, M    | Abdominal + back pain             | 10 mo    | CT of the abdomen/pelvis                    | DVT + irregular use of AC Celect; strut cut flush with the IVC + repair of the duodenum (no cavotomy) No complications; resolution of symptoms |
| Obman et al.      | 40, F    | Upper abdominal pain              | 15 y     | EGD + CT of the abdomen/pelvis             | Severe trauma Greenfield; repair of the duodenum + extraction of the filter (cavotomy) No complications; resolution of symptoms |

Continued
| Author (year)* | Age, sex | Clinical presentation | Interval from placement and diagnostic modality | Indications | Type of IVC filter and treatment modality | Complications and outcomes |
|----------------|----------|-----------------------|-----------------------------------------------|-------------|----------------------------------------|---------------------------|
| Becher et al. (2010) | 42, M | Back pain | 10 mo; CT of the abdomen/pelvis | Traumatic SAH + multi-organ injury | Celect; repair of the aortic pseudoaneurysm, extraction of the filter (cavotomy) | Right renal artery pseudoaneurysm requiring nephrectomy; resolution of symptoms |
| Bathla et al. (2011) | 76, F | GI bleed | 14 mo; EGD + CT of the abdomen/pelvis | Recurrent DVT despite full AC | Celect; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Shang et al. (2011) | 58, M | Epigastric pain | 10 y; EGD + CT of the abdomen/pelvis + UGI series | DVT + trauma | Bird’s nest; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Widmer et al. (2011) | 61, F | RUQ abdominal pain | 1 y; EGD + CT of the abdomen/pelvis | DVT | NR; NR | NR |
| Conolly et al. (2012) | 49, M; 50–58, F (3 patients) | Abdominal pain | 5 mo–3 y, CT of the abdomen/pelvis | DVT + PE, surgical VTE, PE + hypercoagulable state | 2 Bard Recovery filters, Bard G2, Celect; repair of the duodenum + extraction of the filter (cavotomy or sheath based open retrieval of the filter) | NR |
| Malgor et al. (2012) | 61, F | Epigastric pain | 3 y; EGD + CT of the abdomen/pelvis | DVT + PE | Bard G2; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Bae et al. (2012) | 33, F | Epigastric pain + dyspepsia | 8 mo; EGD + CT of the abdomen/pelvis | DVT during pregnancy | NR; strut cut flush with the IVC + repair of the duodenum (no cavotomy) | Post-operative ileus; resolution of symptoms |
| Caldwell et al. (2012) | 47, F | Abdominal pain + GI bleed, CT of the abdomen/pelvis | 3 y; CT of the abdomen/pelvis | DVT + obesity, pre-operatively before Roux-en-Y | Bard G2; endovascular extraction | No complications; resolution of symptoms |
| Antonoff et al. (2012) | 62, M | Incidental CT scan findings | 25 y; CT of the abdomen/pelvis + EGD | Protein C deficiency + prolonged hospitalisation after abdominal surgeries | Miles IVC clip; repair of the duodenum + clip extraction + IVC ligation | No complications; resolution of symptoms |
| Rondonotti et al. (2013) | 57, F | GI bleed | 4 y; EGD + capsule endoscopy + CT of the abdomen/pelvis | DVT + factor V mutation + multiple myeloma | NR; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Reference            | Age | Gender | Symptoms                  | Procedures                                                                 | Outcomes                                                                 |
|----------------------|-----|--------|---------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Dat et al. (2014)    | 60  | F      | Epigastric pain + GI bleed| 1 y; EGD + CT of the abdomen/pelvis; DVT + PE + bleeding; Celect; strut cut flush with the IVC + repair of the duodenum (no cavotomy); repair of the duodenum (no cavotomy); resolution of symptoms | Failed attempt during index surgery due to significant haemorrhage; patient required second surgery; resolution of symptoms |
| Ishida et al. (2014) | 41  | M      | Routine EGD               | 18 mo; EGD + CT of the abdomen/pelvis; DVT + PE; ALN filter; strut cut flush with the IVC + repair of the duodenum (no cavotomy); repair of the duodenum (no cavotomy); resolution of symptoms | No complications; resolution of symptoms |
| Park et al. (2014)   | 46  | M      | Abdominal pain            | 6 y; EGD + CT of the abdomen/pelvis; DVT + paraplegia; NR; conservative management with abdominal pain attributed to urological causes | No complications; resolution of symptoms |
| Jehangir et al.      | 67  | F      | RUQ abdominal pain        | NR; EGD + CT of the abdomen/pelvis; DVT; NR; repair of the duodenum + extraction of the filter (cavotomy); resolution of symptoms | No complications; resolution of symptoms |
| Genovese et al.      | 29–49 | M | Abdominal pain + GI intolerance | 2 mo–5 y; EGD + CT of the abdomen pelvis; DVT/PE polytrauma, paraplegia | 7 Celect, 2 Recovery; 2 patients had open repair of the duodenum + extraction of the filter (cavotomy); 6 patients had successful endovascular extraction; one patient had a failed endovascular extraction; resolution of symptoms in all patients |
| Venturini et al.     | 45  | M      | Asymptomatic              | 5 y; CT of the abdomen/pelvis + cavagram; DVT + PE; ALN filter; endovascular extraction | No complications; resolution of symptoms |
| Pokharel et al.      | 67  | F      | RUQ abdominal pain        | 6 mo; CT of the abdomen/pelvis; PE + groin haematoma; NR; endovascular extraction | No complications; resolution of symptoms |
| Williams et al.      | 32  | F      | Epigastric abdominal pain | 12 mo; CT of the abdomen/pelvis; DVT + contraindication to AC | Celect; endovascular extraction; resolution of symptoms |
| Fernandez-Moure et al. (2017) | 67  | M      | Abdominal pain + GI bleed | 1 y; EGD + CT of the abdomen/pelvis; DVT + craniotomy for brain tumour | Celect; endovascular extraction; resolution of symptoms |

Continued
| Author (year)* | Age, sex | Clinical presentation | Interval from placement and diagnostic modality | Indications | Type of IVC filter and treatment modality | Complications and outcomes |
|---------------|---------|-----------------------|-----------------------------------------------|-------------|---------------------------------------------|--------------------------|
| Kishor Jha et al. (2017) | 47, F | Abdominal pain + dyspepsia | 20 y; venography + CT of the abdomen/pelvis | DVT + contraindication to AC | NR; repair of the duodenum + extraction of the filter (cavotomy) + ligation of the IVC | MRSA bacteraemia; resolution of symptoms |
| McKelvie et al. (2017) | 39, F | Asymptomatic, found during serial imaging | 14 mo; EGD + CT of the abdomen/pelvis | DVT despite AC | Celect; unsuccessful endovascular extraction | NR |
| Lee et al. (2019) | 63, F | Routine EGD | 19 mo; EGD + AXR + CT of the abdomen/pelvis | DVT + iliac vein perforation | Celect; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Hongo et al. (2019) | 43, M | GI bleed | 12 y; EGD + CT of the abdomen/pelvis | DVT + trauma | NR; conservative management | No complications; resolution of GI bleed |
| Shimizu et al. (2019) | 35, M | Epigastric pain | 3 y; EGD + CT of the abdomen/pelvis | PE prevention after iatrogenic left iliac vein injury with DVT + malignancy | ALN filter; repair of the duodenum by EGD clipping + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Halim et al. (2021) | 28, F 55, M | Abdominal pain | NR; EGD + CT of the abdomen/pelvis | DVT | NR; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Parikh et al. (2021) | 33, M | Epigastric abdominal pain | 10 y; CT of the abdomen/pelvis | Recurrent DVT + paraplegia | Bird’s nest; repair of the duodenum + strut cut flush with the IVC (no cavotomy) | No complications; resolution of symptoms |
| Khan et al. (2021) | 33, F | Epigastric pain | 13 y; EGD + CT of the abdomen/pelvis | DVT + paraplegia | Celect; repair of the duodenum + extraction of the filter (cavotomy) | No complications; resolution of symptoms |
| Tanabe et al. (2022) | 26, M | GI bleed | 8 y; EGD + CT of the abdomen/pelvis | IVC tumour embolisation | NR; repair of the duodenum + strut cut flush with the IVC + endovascular extraction | No complications; resolution of symptoms |

M = male; RUQ = right upper quadrant; AXR = abdominal Xray; PE = pulmonary embolism; NR = not reported; AC = anticoagulation; F = female; EGD = oesophagogastrroduodenoscopy; CT = computed tomography; DVT = deep vein thrombosis; CP = chest pain; SOB = shortness of breath; GI = gastrointestinal; CVA = cerebrovascular accident; BE = barium enema; US = ultrasound; SB = small bowel; UGI = upper gastrointestinal; ERCP = endoscopic retrograde cholangiopancreatography; DUS = duplex ultrasound; SAH = subarachnoid haemorrhage; VTE = venous thrombo-embolism; MRSA = meticillin resistant *Staphylococcus aureus*.

* See Supplementary Appendix S1 for the full references.
Symptomatic penetrations of IVC filters can be managed with both endovascular techniques and surgical interventions. In the current literature there are a total of 49 case reports and case series describing cases with duodenal perforation (Table 1). Laparotomy, venotomy with extraction of the filter, and direct repair of the duodenum was described in 25 patients. In situations when the IVC was thrombosed, en bloc segmental resection of the IVC with the filter in situ was performed. In 10 patients who had a significant inflammatory reaction around the filter the struts were cut flush with the IVC and the duodenum was repaired, leaving the remaining portion of the filter in the IVC. Complications after an abdominal approach were described in two patients, which included significant bleeding requiring a second operation for haemorrhage control and IVC filter strut removal. One patient developed right renal artery pseudo-aneurysm requiring nephrectomy secondary to the IVC filter struting the aortic wall. Two patients had delayed return of GI function secondary to post-operative ileus and small bowel obstruction, and one patient died after a prolonged stay in hospital. Several authors have described endovascular retrieval in symptomatic patients who had duodenal, aortic, or vertebral penetration by an IVC filter. The filter was retrieved in 12 patients, and two patients had a failed attempt. All patients were maintained on broad spectrum antibiotics perioperatively, to prevent intra-abdominal sepsis. In cases of aortic wall penetration, femoral artery access was maintained intra-operatively for potential haemorrhage control. Table 1 provides a detailed workup list and treatment.

In the current era of minimally invasive surgery there are also several reports of laparoscopic assisted, retroperitoneal laparoscopic, and even robotic assisted retrievals of an IVC filter. These approaches did not demonstrate decreased duration of hospital stay vs. open techniques, and several patients experienced post-operative fever and haematuria. The conventional endovascular approach to remove an IVC filter revolves around retrieving the filter using a snare with a co-axial sheath. Several adjunctive manoeuvres, such as stiff wire displacement, loop snare realignment, wire loop and snare sling techniques, angioplasty balloon displacement, parallel wire and snare flossing, and dissection with endobronchial forceps, can aid the process. Another alternative is endovascular IVC filter retrieval using an excimer laser sheath, which has been described as safe and effective in extracting embedded filters.

Despite advances in techniques, endovascular attempts at retrieval have their own set of complications. There have been cases of strut bending with non-collapsibility into the jugular sheath, which requires urgent open surgery. There is also potential for strut fracture with migration to the right ventricle and pulmonary artery. The complication rate for endovascular retrieval that requires adjuncts beyond standard snare and sheath varies from 5.3% to 20.6% between series.

In conclusion, an IVC filter causing duodenal perforation is a rare complication with non-specific symptoms. Multimodal imaging and diagnostic studies should be used to rule out other more likely causes of a patient’s symptoms. Consultation with gastroenterology should be considered. When all other reasonable causes have been excluded, direct filter removal can be performed safely using established endovascular or open surgical techniques. As the present case demonstrates, safe removal of the filter can be performed in the context of previous abdominal surgery.

CONFLICTS OF INTEREST
None.

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APPENDIX A. SUPPLEMENTARY DATA
Supplementary data related to this article can be found at https://doi.org/10.1016/j.ejvsvf.2022.06.001.

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