

Inferior vena cava filter penetration following Whipple surgical procedure causing ureteral injury

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ABSTRACT

We report a case of an indwelling inferior vena cava filter that penetrated the IVC wall after Whipple's pancreatico-duodenectomy procedure performed in a patient with ampullary carcinoma, resulting in right ureteral injury and obstruction with subsequent hydroureter and hydronephrosis. This was incidentally discovered on a computed tomography scan performed as routine follow up to evaluate the results of the surgery. We retrieved the inferior vena cava filter and placed a nephrostomy catheter to relieve the ureteral obstruction. Our case highlights the importance of careful inferior vena cava manipulation during abdominal surgery in the presence of an inferior vena cava filter, and the option of temporary removal of the filter to be placed again after surgery in order to avoid this complication, unless protection is required against clot migration during the surgical procedure.

CASE REPORT

CASE REPORT

An 80-year old male with epigastric pain and jaundice, initially thought to be due to pancreatitis (Fig 1), but was found to have a fungating pancreatic mass on Endoscopic Retrograde Cholangiopancreatography (ERCP). A common bile duct stent was placed at an outside hospital to relieve the biliary obstruction. The patient was transferred to our hospital for evaluation and staging of his pancreatic cancer and possible surgical resection. During the course of his hospital stay, he developed lower extremity swelling which was investigated using ultrasound. A non-occlusive thrombus was found in the right common femoral vein. The clinical team requested an inferior vena cava (IVC) filter placement to prevent pulmonary embolism (PE), since a planned Whipple procedure constituted a contraindication to anticoagulation. An IVC filter (Gunther Tulip; Cook, Bloomington, Indiana) was deployed after initial IVC venogram to measure IVC diameters and confirm normal flow through IVC and renal veins. The filter was placed infrarenally at the level of renal veins influx

opposite L1 through a right femoral approach without complication (Fig 2).

Whipple's pancreatico-duodenectomy was subsequently performed. The intraoperative course was uneventful except for unintentional perforation of the right hepatic artery. The bile duct was extremely inflamed and marked adherence was noted between duodenum and pancreas which necessitates division of the omentum. No excessive manipulation of the IVC was reported. During his postoperative course, the patient had leucocytosis and a pancreatic leak resulting in a peri-pancreatic fluid collection for which he was prescribed antibiotics. The patient was discharged 10 days after his procedure. A computed tomography (CT) scan performed during a follow up visit 1 month after his surgery revealed a residual peri-pancreatic fluid collection. Unexpectedly, the coronal reconstructed images showed that the previously placed filter was tilted and 2 of its struts had penetrated the IVC wall laterally causing injury to the proximal right ureter and resulting in proximal hydroureter and hydronephrosis (Fig.

3). This angulation was a distinct change from the previous appearance of the filter.

The urology service was consulted and a recommendation was made to perform a radioisotope renal scan to diagnose ureteral leakage and to evaluate the renal function. The renal scan showed persistent tracer uptake in multiple calyces as well as time activity curve analysis consistent with partial obstruction (Fig. 4). More importantly, there was extra-renal tracer that appeared just caudal to the right kidney with subsequent filling of the drainage bulb of the JP drain that was placed during the pancreatico-duodenectomy in the subhepatic space (Fig. 4). Delayed images were obtained over this drainage bulb confirming this finding, which was suggestive of injury to the right collecting system with urine leak (Fig. 4). After an unsuccessful attempt to place a ureteral stent through a retrograde approach by the urology service due to upper ureteral obstruction, the patient was referred to Interventional Radiology for nephrostomy catheter placement. The initial nephrostogram showed obstruction of the proximal right ureter at the level of L2-L3, where one of the filter's struts was in contact with the ureter. The ureteral obstruction resulted in moderate proximal hydronephrosis and hydroureter, with extravasation of contrast around the renal pelvis and proximal ureter (Fig. 5). Multiple attempts to cross the ureteral obstruction were unsuccessful. The IVC filter was retrieved later through a right transjugular approach with a snare system after performing IVC cavogram that showed patent IVC with no filling defects and no extravascular contrast leak. The venacavogram performed before filter retrieval showed significant tilt and caudal migration of the filter when compared with the initial filter placement images. There were 2 IVC filter struts projecting outside the confinement of the IVC lumen consistent with filter penetration (Fig. 6). No contrast extravasation was depicted at that time; however, the patient immediately noticed bloody urine from his nephrostomy tube following filter retrieval, which resolved after a few days. The proximal right ureteral obstruction remained unchanged on serial follow-up nephrostogram and ureterogram studies performed up to 8 months following his surgery suggesting irreversible ureteral injury and scarring resulting from penetration of the filter struts into the right ureter (Fig. 7). The patient continues to exchange his right nephrostomy catheter every 8 weeks since its placement.

DISCUSSION

Surgical insertion of IVC filters was pioneered in the 1960s, but was used infrequently until the development of the percutaneous IVC filter insertion technique in 1973 by Greenfield [1]. IVC filters have been proven to prevent fatal and non-fatal pulmonary emboli arising from lower extremity DVT in the vast majority of patients and are recommended for patients who cannot receive anticoagulants [2]. Stein and colleagues, in an observational study of the National hospital discharge survey database, concluded that the number of patients who had IVC filters increased from 2000 patients in 1979, to 49000 patients in 1999.

According to the American college of chest physician (ACCP) recommendations, inferior vena cava filters are generally placed in patients with acute PE or deep venous thrombosis (DVT) who have a contraindication to anticoagulation [1]. In 1999, 45% of IVC filter insertions were in patients with DVT alone, 36% were in patients with PE, and 19% were in patients who presumably were at high risk but did not have DVT or PE listed as a discharge code [3].

Morbidity from IVC filter placement is quite low, regardless of which filter is used. Athanasoulis and colleagues reported a series of 1765 IVC filter insertions with only 0.3 % major complication rate [4]. Complications of IVC filters include local complications, such as hematoma at the access site, filter migration, filter penetration, filter fracture with embolization of the fractured fragments, and IVC thrombosis [4-7]. Among these, symptomatic penetration is rare with reported incidence of about 0.4 % [8].

We report a case of an IVC filter that was placed in a patient suffering from DVT, who underwent a planned Whipple's pancreatico-duodenectomy for ampullary carcinoma. The filter penetrated the IVC resulting in right ureteral injury with subsequent proximal hydronephrosis and hydroureter. This eventually led to ureteral scarring, necessitating life-long nephrostomy to drain the right kidney after failure of ureteric stenting.

Etiology & Demographics:

Complications of IVC filter placement can be divided into 2 categories; complications related to filter insertion, and late complications [5]. Complications related to IVC filter placement account for less than 0.5% morbidity rate and include; pneumothorax, wound hematoma or bleeding, and arterial injury including arterio-venous fistula. However, the risk is further decreased when access is achieved using ultrasound guidance and by correction of the patient's coagulopathies. Additional IVC filter insertion-related risks include filter malposition which occurs at a rate of 0.7-4.6%, and excessive filter tilt which occurs at a rate of 0%-56% [5]. These may result from operator errors during deployment and failure to recognize major IVC anomalies. Filter tilt of more than 15 degrees has been shown to be a risk factor for PE. Filter malposition and tilt can be decreased with a pre-insertion cavography, use of proper equipment, and adequate attention to detail [5].

Late complications include caval thrombosis as well as filter migration, penetration and filter fracture. Filter migration is defined as cranial or caudal migration of greater than 1.0 cm and is thought to result from aortic pulsation and respiratory motion [9]. These mechanisms also likely contribute to transmural penetration of the IVC wall, which is defined as strut perforation of the IVC wall into the pericaval space. This is surprisingly common, occurring at a high rate of approximately 25%-30% [2]. Despite possible overestimations, penetration remains a real potential risk of IVC filter placement, and there are significant differences between different filter types [10]

The mechanism of filter penetration is not fully understood. One explanation for this is the slow adaptation of the cava to the radial force caused by filter placement [10]. As the hooks gradually move through the medial and adventitial vessel wall layers, myointimal remodeling occurs resulting in protective fibrous-coating around the hooks, as demonstrated by Proctor and colleagues in animal models [11]. (Table1).

Clinical & Imaging findings:

Trans-mural penetration is most commonly asymptomatic and usually detected incidentally on imaging or at the time of filter removal [9]. However penetration may result in injury to contiguous organs including the duodenum and aorta, resulting in duodenal perforation and ulceration, hemorrhage, arteriovenous fistula, and heart failure necessitating operative intervention [5,12]. A review of the literature revealed a published case report of filter penetration that was managed surgically [13]. There is also another case report of an IVC filter penetrating the renal pelvis and resulting in rupture with urinoma formation [2].

In our case, surgical manipulation of the IVC during a Whipple's procedure resulted in about a 2 cm caudal migration of the filter as well as filter penetration resulting in injury to the adjacent right ureter with subsequent development of proximal hydroureter and hydronephrosis.

Treatment & Prognosis:

The described IVC filter related complication in our case has not been previously reported in the literature. Even though the filter was retrieved, the ureteric injury hindered placement of ureteral stents across the site of injury and resulted in chronic irritation, fibrosis, and scarring of the ureter. Our case highlights the importance of either careful manipulation of the IVC during surgical procedures or, temporary removal of the filter and then replacement after surgery, if the risk of thrombus dislodgement during surgery is minimal. Baskara and colleagues recommended surgical intervention to relieve the ureteric obstruction in cases of ureteric injury caused by the IVC filter penetration [13].

Differential Diagnoses:

Differential diagnosis of a penetrating IVC filter causing ureteral injury and stricture may include:

Congenital ureteral stricture is commonly seen at the pelvi-ureteric and uretero-vesical junction [14]. Acquired causes of stricture may include iatrogenic cause which is commonly associated with endouretral procedures [15]. Chronic impacted ureteral stone may result in benign stricture [16]. Tuberculosis of the ureter can be present with beaded ureter due to multi-segment strictures which may end up forming pipe-stem ureter [17]. Ureteric primary malignancy or secondary malignancy can present as malignant stricture of the ureter due to soft tissue growth [18]. Moreover, radiation therapy of pelvic tumors can be complicated by radiation induced ureteral stricture [18] (Table 2).

TEACHING POINT

Careful manipulation of the IVC during abdominal surgery in the presence of an IVC filter is crucial to avoid IVC filter-related penetration. Retrieving the IVC filter temporarily before the operation and performing filter redeployment after surgery is still an option. The presented case highlights the possibility of ureteral irritation and scarring secondary to prolonged penetration of the ureter by an IVC filter resulting in ureteral obstruction.

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FIGURES

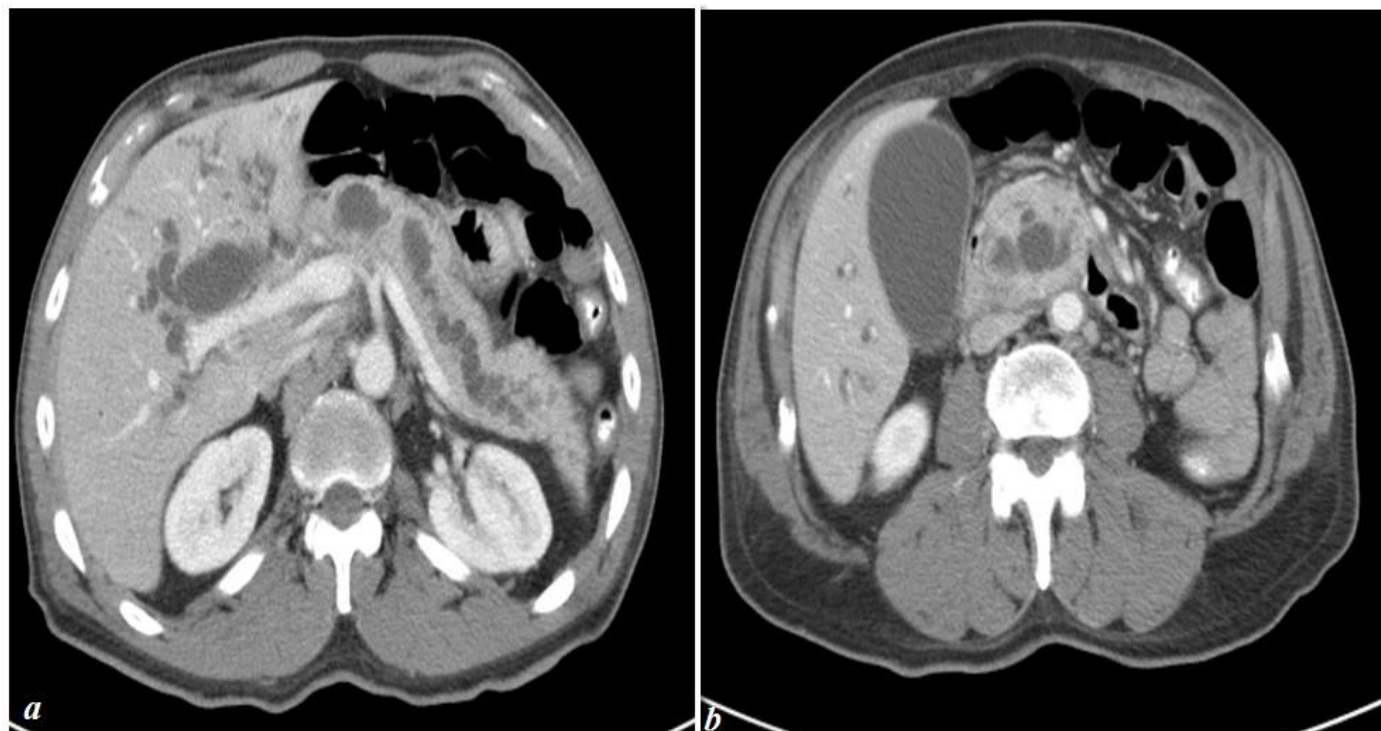


Figure 1: An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. (a) Axial CT image of the abdomen showing marked dilatation of intrahepatic biliary radicals associated with dilated pancreatic duct. (b) A mixed density pancreatic head mass lesion is noted without infiltration of the IVC. Technique: 120kV. 282mAs, 5 mm slice thickness, Intravenous contrast: 120 mL of contrast medium.

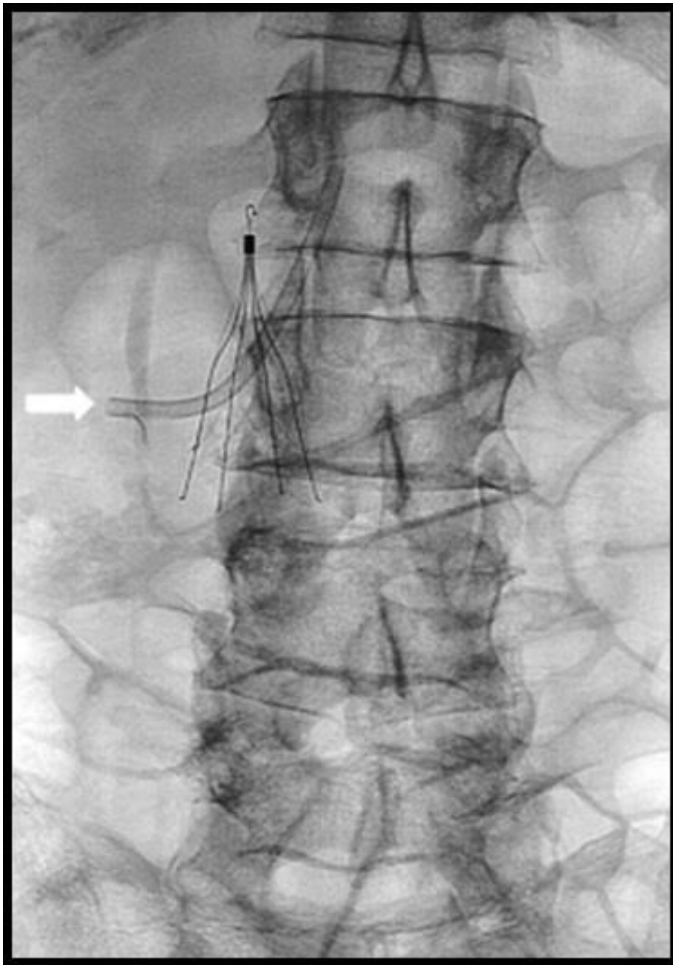
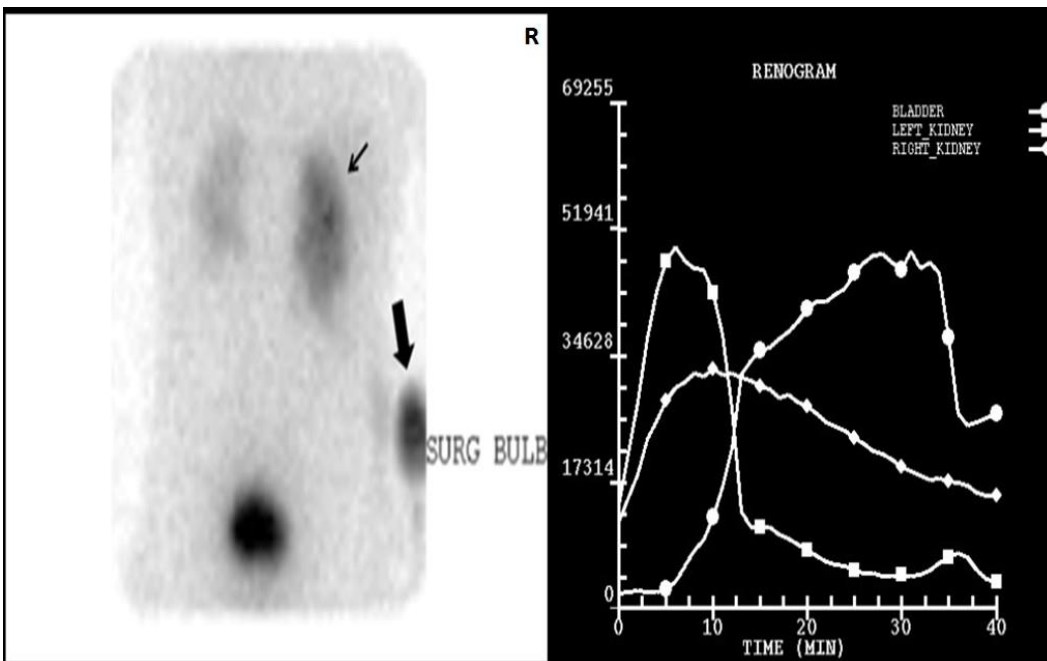


Figure 2: An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. Plain radiograph of the abdomen demonstrates an IVC filter deployed infrarenally at the level of L1. An endoscopically placed plastic biliary stent (arrow) is also noted. Technique: 80kV., 3mAs.



Figure 3: An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. Reformatted Coronal CT image of the abdomen showing a tilted IVC filter with a filter strut (small arrow) penetrating the lateral wall of the vena cava causing injury to the proximal right ureter and resulting in proximal hydronephrosis (large arrow). Note there is an infra-hepatic Jackson-Pratt (JP) drain (arrow head). Technique: 120kV. 285mAs, 5 mm slice thickness, Intravenous contrast: 120 mL of contrast medium.

Figure 4 (bottom): An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. (a) Radioisotope renal scan showing persistent tracer uptake in multiple calyces (small arrow) and filling of the drainage bulb of the Jackson-Pratt (JP) drain that was placed during the Whipple's procedure. (b) Time activity curve analysis consistent with partial renal obstruction. Technique: 3.39 mCi Tc-99m MAG3 I.V.



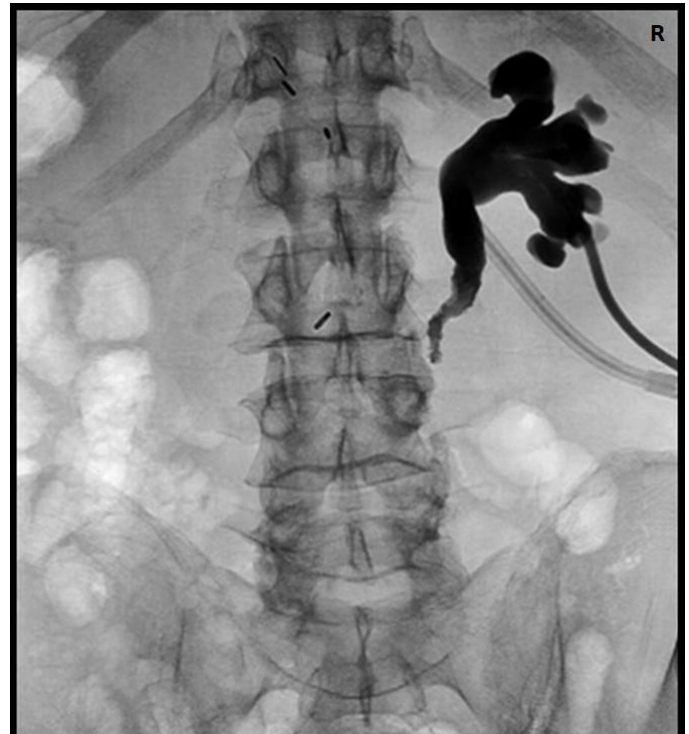
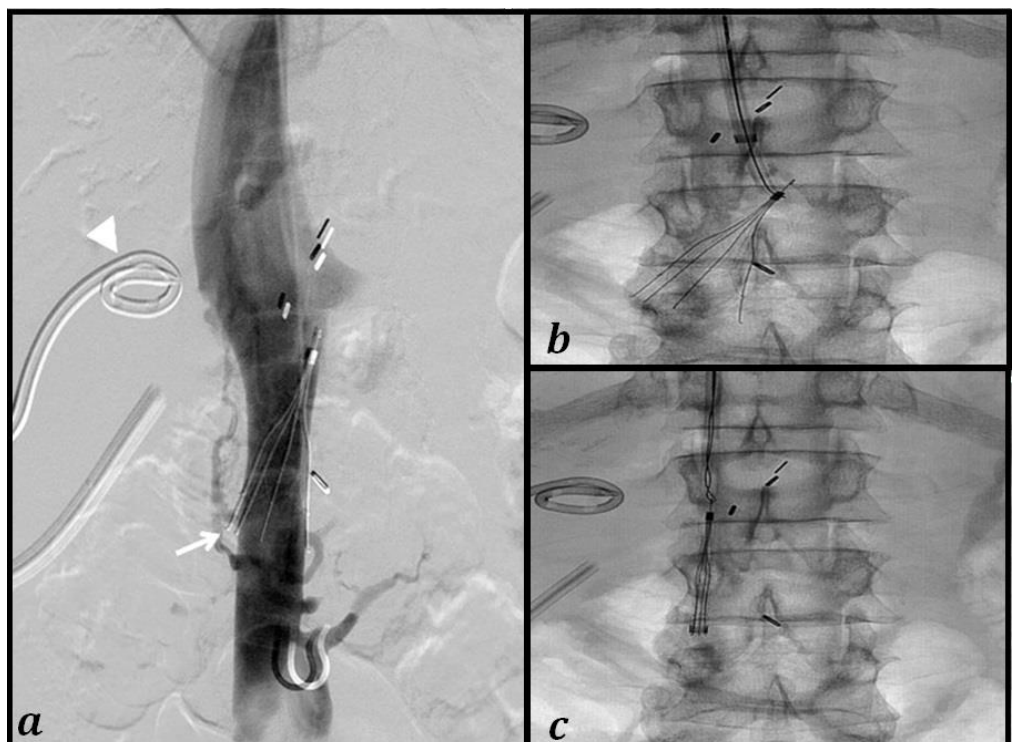


Figure 5: An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. Nephrostogram showing obstruction of the proximal right ureter (large arrow) at a level where one of the filter's struts (small arrow) is in contact with the ureter. The ureteral obstruction resulted in moderate proximal hydroureter and hydronephrosis with extravasation of contrast around the renal pelvis and proximal ureter (arrowhead). Note that the IVC filter migrated caudally when its position is compared to that in figure 2. Technique: 86kV., 4mAs.

Figure 7: An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. Follow up nephrostogram performed 8 months following his surgery showing persistent hydroureter and hydronephrosis with continued obstruction at the same level as before. Technique: 80kV., 10mAs.

Figure 6 (right): An 80-year-old male patient with a history of periampullary pancreatic adenocarcinoma who underwent Whipple's pancreatico-duodenectomy procedure resulting in IVC filter penetration and chronic ureteral injury. (a) Venacavogram performed before filter retrieval showing significant tilt and caudal migration of the filter when compared to figure 2. There are 2 IVC filter struts (small arrow) projecting outside the confinement of the IVC lumen suggesting filter penetration. Note the nephrostomy catheter (arrowhead) placed in the right kidney. (b) and (c) images showing filter retrieval. Technique: 85kV., 26mAs., FOV 17.



Etiology	IVC manipulation during abdominal surgery in the presence of an IVC filter.
Incidence	IVC penetration: Occurs at a high rate of approximately 25%-30%.
Gender ratio	No specific sex predilection.
Age predilection	No specific age predilection.
Risk Factors	Some filters have high rate of penetration than others.
Treatment	Transvenous retrieval of IVC filter and Percutaneous nephrostomy to the affected kidney.
Prognosis	Chronic irritation, fibrosis, and scarring of the ureter results from the ureteric injury hindering placement of ureteral stents across the site of injury with subsequent nephrostomy tube placement.
Finding on imaging	IVC filter with filter struts penetrating the lateral wall of the vena cava causing injury of the proximal right ureter and resulting in proximal hydroureter and hydronephrosis.

Table 1: Summary table for Inferior vena cava filter penetration following abdominal surgical procedure causing ureteral injury.

Differential diagnosis	Intravenous pyelography / CT findings
<i>Congenital stricture</i>	Smooth stricture usually noted at pelvi-ureteric and uretero-vesical junction.
<i>Iatrogenic stricture</i>	Most commonly noted with endourological procedures.
<i>Chronic impacted ureteral Calculus</i>	Can result in benign stricture of the ureter.
<i>Tuberculosis of the ureter</i>	Ureteral wall thickening is usually noted in acute stage. Beaded appearance and pipe-stem ureter can be presented with the disease chronicity.
<i>Ureteral malignancy</i>	Stricture of the ureter with abnormal filling defects which can be presented by abnormal soft tissue thickening of the ureter.
<i>Radiation induce ureteric stricture</i>	Stricture of the ureter after radiotherapy in patients with pelvic malignancy.

Table 2: Differential diagnosis table of Inferior vena cava filter penetration causing ureteral injury.

ABBREVIATIONS

- ACCP: American college of chest physician
- CT: Computed tomography
- DVT: Deep venous thrombosis
- ERCP: Endoscopic Retrograde Cholangiopancreatography
- IVC: Inferior vena cava
- PE: Pulmonary embolism

KEYWORDS

IVC filter; Ureteral injury; Hydroureter; Hydronephrosis; penetration; Whipple procedure

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