



Filter Placement for Duplicated Cava

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Abstract

Anatomic variations of the inferior vena cava (IVC) are found in 3-5% of the population. IVC duplication is a well-known anatomic variation that is important when relevant procedures are being planned. Therefore, the identification of IVC anomalies should be checked prior to pertinent interventions. We report two cases of dual IVC filter placement for duplicated cava including a missing left inferior vena cava and subsequent pulmonary embolism. The rationale of one versus two filters and the current literature are discussed.

Keywords

inferior vena cava anomalies, deep venous thrombosis, inferior vena cava filter

Introduction

The incidence of duplicated inferior vena cava (IVC) in the general population has been reported between 0.3% and 3%.¹ The embryogenesis of the defect is most likely due to a nonregression of the supracardinal veins during the fetal development.¹

The absolute indications for IVC interruption comprise new onset of pulmonary thromboembolism despite therapeutic levels of anticoagulation contraindications to anticoagulation.² Conversely, the relative indications apply to patients with VTE that may be subjected to devastating negative outcomes of bleeding or death if on anticoagulation or pulmonary embolism (PE) in patients with low cardio-pulmonary reserve.³

The indication of IVC filters in patients with duplicated vena cava remains the same as for the patients with single IVC. Nonetheless, the experience of interruption of the IVC in patients who sustain duplication is restricted to case reports.⁴⁻¹⁰

We report 2 cases of dual IVC filter placement for duplicated cava including a patient who developed PE and had the left IVC initially missed.

Case I

The patient was a 27-year-old female who presented with right deep venous thrombosis (DVT) after 21 days from vaginal delivery following uneventful pregnancy course with no history of miscarriage, abortion, or previous pregnancies. The past medical history was significant for celiac disease. Of note, she had a positive family history of spontaneous DVT that was identified with the patient's grandmother. She had a 10-pack-year of smoking history, but she quit a year prior to the pregnancy.

Initial clinical presentation was right lower extremity pain and edema. She was investigated with duplex ultrasound (DUS) that showed femoropopliteal and calf vein thrombosis.

At the moment of the DVT diagnosis, she was started on therapeutic low-molecular weight heparin (LMWH) and coumadin. A plan to continue anticoagulation for 3 months was made. Prior to initiation of anticoagulation, the patient underwent investigation for thrombophilia (protein C and S, factor V Leiden, antithrombin III mutation genes, and antinuclear antigen, homocysteine, anticardiolipin). All tests were normal.

Three weeks after the DVT, the patient presented with worsening of pain and edema in the right lower extremity as well as right-sided pleuritic pain without spontaneous resolution. At the moment of admission, she had a supra-therapeutic international normalized ratio (INR) of 3.8, normal cardiac enzymes, and unremarkable electrocardiogram. The patient was followed with her primary care doctor who reported therapeutic INR greater than 2 in the first visit and compliance with the regimen.

Chest CT and CT venography revealed a right main pulmonary artery thrombus, right external iliac to popliteal DVT, and a duplicated IVC (Figure 1A and B). A 2D echo showed a right ventricle wall hypokinesis in the presence of normal apical contractility and no foramen ovale. The patient was therefore started on heparin drip and admitted to intermediate-telemetry care unit. A multidisciplinary approach was conducted by hematology, pulmonary/critical care, and vascular

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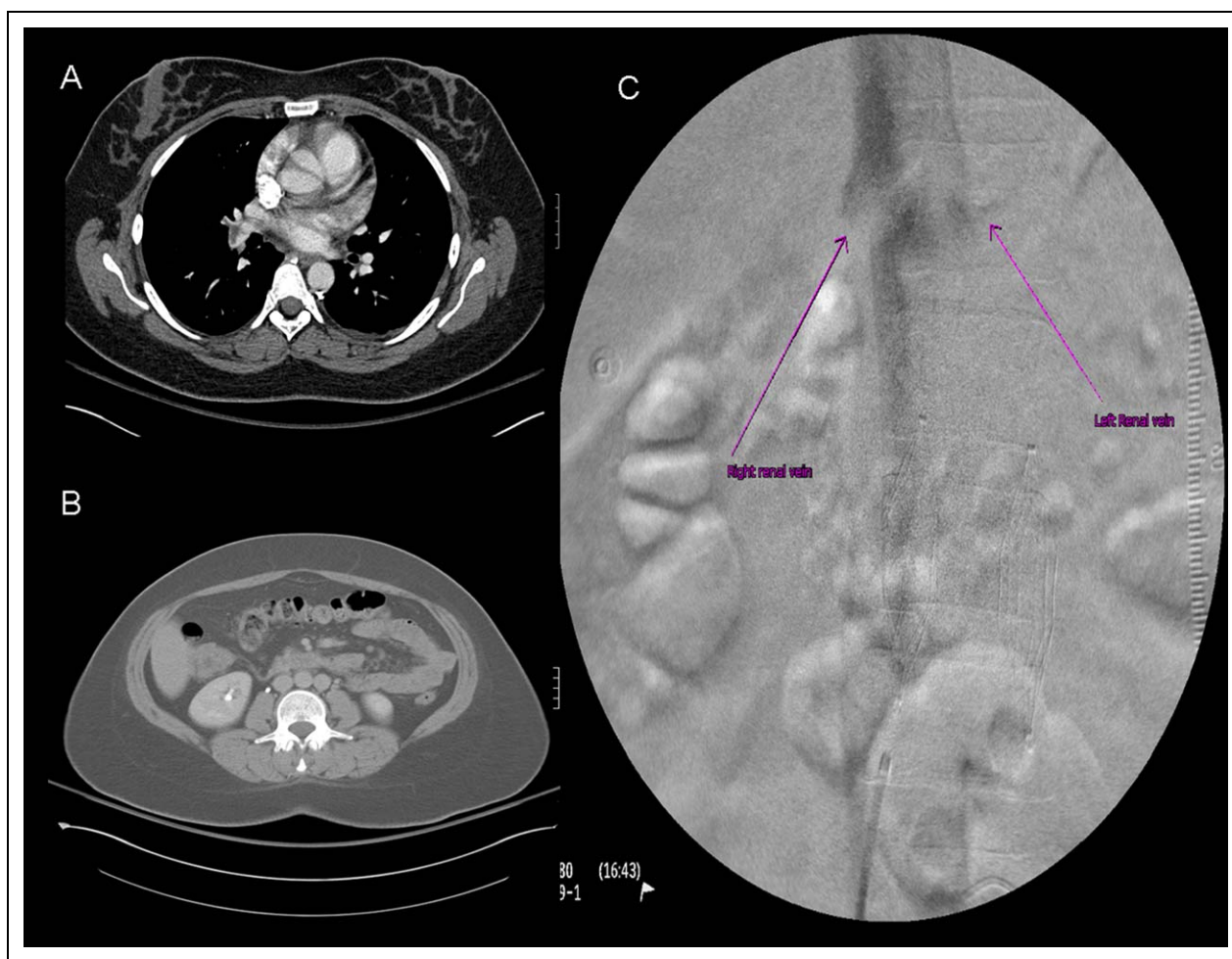


Figure 1. A, computed tomography angiogram (CTA) of the chest depicting thrombus in the distal aspect of the right main pulmonary artery, partially filling a 3.0 mm-lumen defect. B, CT venogram of the abdomen showing duplicated inferior vena cava (IVC). Both veins have similar diameter. C, Completion venogram depicts bilateral IVC filters appropriately placed below the level of the renal veins.

surgery team. Given the patient's history on admission, she was felt to be at increased risk for a new PE episode based on the failure of preventing PE despite therapeutic anticoagulation with Coumadin.

Under conscious sedation with local anesthesia in the operating room, a first venogram was obtained, which demonstrated a patent left iliac, left vena cava, and left renal vein. A communicating inter-iliac vein and the right vena cava were identified after a venogram was obtained using 30-degree right anterior oblique view. Subsequently, a Bentson 0.035" guide wire was advanced through the caval confluence to the right vena cava. Another cavogram was then obtained confirming patency of the right IVC and right renal vein.

Based on the sizing of the vena cava (right, 15.9 mm and left, 15.3 mm), a 6F catheter sheath was exchanged over the wire. An OptEase (Cordis Endovascular, Miami, Florida) filter was successfully deployed in infrarenal position in both IVC. A completion venogram demonstrated both IVC being patent as shown in Figure 1C.

Postoperatively, the patient recovered well with no local or systemic complications being discharged from the hospital on

the third postprocedure day on anticoagulation. She has had an uneventful 6-months follow-up with no further complications.

Case 2

A 49-year-old female presented with increasing swelling and pain in the right lower extremity (ankle and calf, calf circumference 3 cm larger than the left) 5 days after a 7-hour drive. She had a smoking history of 18 pack years, hypertension controlled with 1 medication, no previous surgery, and a positive family history of DVT from her father. She eventually underwent a DUS that revealed DVT in the right femoral, popliteal, and calf veins (Figure 2A). In addition to the imaging study, the patient was tested for thrombophilia prior to the treatment. She was found to have heterozygous Factor V.

She was placed on LMWH and Coumadin but injured her left calf 16 days later and had another DUS that demonstrated rupture of the medial gastrocnemius muscle with a large fresh hematoma (Figure 2B). At that time, the thrombus was found unchanged in the right lower limb. The Coumadin was therefore stopped and a Greenfield (Bard Medical, Convington,

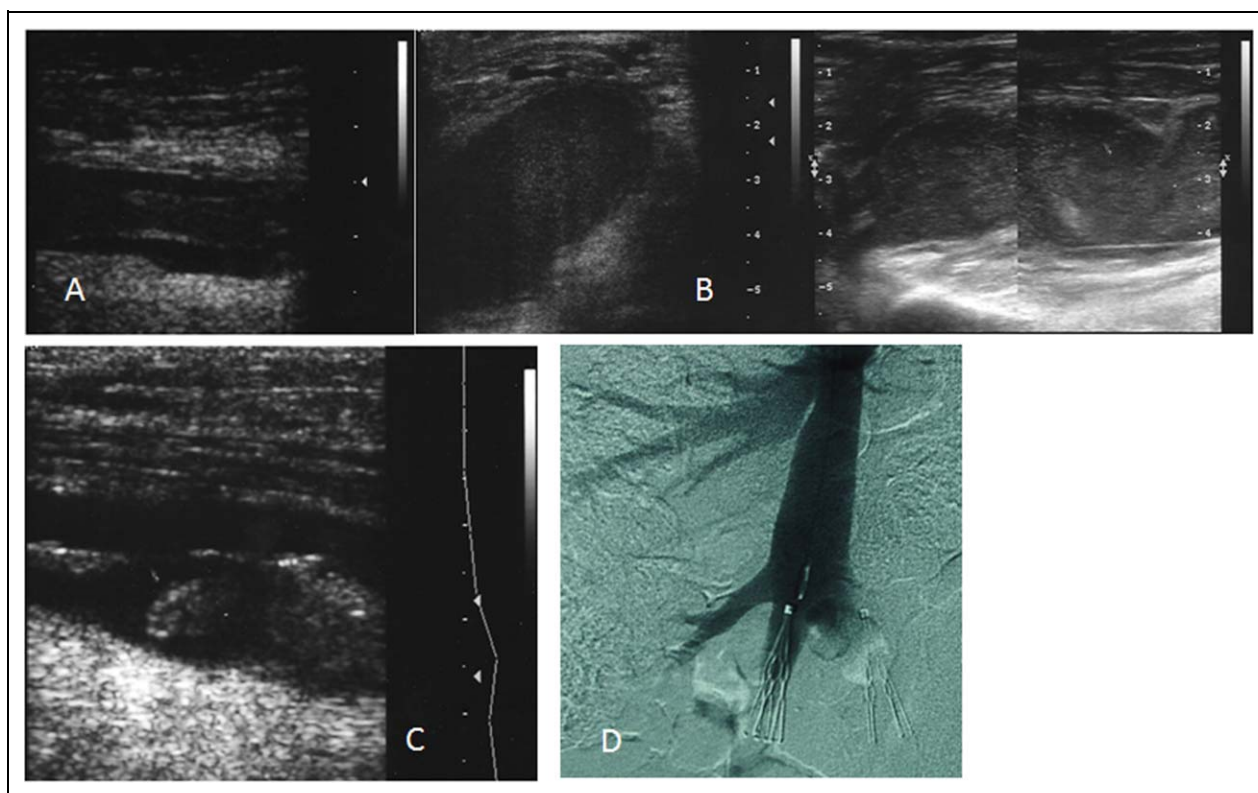


Figure 2. A, Duplex ultrasound image showing an acute thrombus in the right popliteal vein. B, Ultrasound image of the left mid to upper calf demonstrating a fresh hematoma in cross-sectional (left panel of image B) and in the long view (right panel of image B). Only the upper part of the medial head of the gastrocnemius muscle is seen as the rest is covered from the hematoma that occurred after the rupture of the muscle. C, Ultrasound image of the femoral vein showing an acute thrombus at the lower thigh. D, Completion venogram demonstrating the 2 inferior vena cava (IVC) filters one in each cava below the renal veins.

Georgia) filter was placed in the IVC below the renal veins following nonselective cavogram. About 5 days later, the patient presented with shortness of breath and chest pain. She was then transferred to our facility and, subsequently, underwent a computed tomography angiogram (CTA) of the chest that demonstrated bilateral emboli in the segmental and subsegmental pulmonary arteries. It was also noted that the swelling in the left calf and ankle was increased. A DUS showed acute thrombosis of the femoral and popliteal veins (Figure 2C). During the examination of the iliac veins, a duplicated IVC was found. Thus, a venogram was performed and another Greenfield IVC filter was placed in the second IVC on the left side (Figure 2D). After 3 weeks, anticoagulation was resumed for a total of 6 months period.

Partial recanalization with reflux was found in both lower extremities within 1 year. She was encouraged to continue to wear elastic compression stockings. At the last day of follow-up 27 months later, she had mild swelling in both extremities and mild-to-moderate pain in prolonged standing.

Discussion

Endovascular techniques for IVC interruption have been the modality of choice after the popularization of the Greenfield filter.¹¹ Along with the advance of the endovascular technique

and imaging modalities, the congenital anomalies of the IVC have been more often found during the workup for VTE.¹²

In our first case, the patient was on postpartum period with a right lower extremity DVT. She developed a PE despite being on therapeutic anticoagulation. The OptEase was chosen in the first case based on surgeon's preference as it can serve as a permanent or temporary IVC filter.¹³ The indication of IVC filter in our second case was a patient who was unable to continue anticoagulation due to rupture of the contralateral calf muscle with a large expanding hematoma. Yet again, the Greenfield filter was chosen based on surgeon's preference and availability at the moment.

Duplication of the IVC may be found in different diagnostic modalities as CT scan, magnetic resonance imaging (MRI), or DUS during nonrelated VTE imaging workup.¹⁴ Notably, nonselective cavogram is often performed prior to the deployment of vena cava filters, resulting in missed duplicated IVC as shown in our second case. We advocate that selective cavogram must be considered in cases where US, CT, or MRI was not done. Danetz and associates emphasize the indication of selective versus nonselective cavogram prior to IVC filter placement in patients with nonvisualization of the iliac veins confluence or the origin of the contra-lateral common iliac vein.¹⁵ In that series, 15 (37%) patients sustained IVC anomalies that were not detected in the nonselective cavogram. Cheng and associates also reported a case of unidentified duplicated IVC.¹⁶

Table 1. Literature Summary on Interruption of Duplicated Inferior Vena Cava

Dual Filter Placement	Gender/ Age	Presentation	Indication	Device	Complications	Follow-Up
Kartchner et al ²⁴	59, F	DVT + PE	Attempt to prevent massive PE	Mobin-Udden	None	n/r
Rohrer et al ²³	72, M	DVT + PE	Limited cardiopulmonary reserve	Greenfield	None	n/r
Soltes et al, 1992 ²²	90, M	PE	Fall risk, advanced age	Bird's nest	None	6-months
Sugimoto et al ⁹	41, F	Unilateral DVT	VTE despite anticoagulation	Greenfield	None	n/r
Spivack et al ⁸	51, M	Unilateral DVT	VTE despite anticoagulation	Greenfield	None	n/r
Sartori et al ⁵	81, M	Unilateral DVT	Post-neurosurgical procedure ^a	VenaTech LP	None	n/r
Moubarak et al ²¹	61, M	PE	VTE despite anticoagulation	Greenfield	None	24-years
Hashmi et al ¹⁹	70, M	DVT + PE	Frank Hematuria	n/r	None	n/r
Leong et al ²⁰	53, F	Bilateral DVT	Hemorrhage Stroke ^a	ALN	None	n/r
Cheng et al ¹⁶	45, M	Unilateral DVT	Postlaminectomy	n/r	None	nr
IVC filter Placement + Coil embolization						
Smith et al ⁴	55, F	Recurrent DVT/PE	Traumatic intracranial bleed on coumadin for recurrent VTE	VenaTech LGM + Gianturco coils to Lt IVC	None	5 months
Anne et al ^{10, b}	78, F	DVT + PE	Low GI bleed ^a	n/r	None	n/r
Supra-renal filter Placement						
Sugimoto et al ⁹	61, M	Unilateral DVT	Postlaryngectomy ^a	Greenfield	None	18 months
Malgor et al ¹⁸	74, F	Unilateral DVT	Bleeding disorder post-THR ^a	VenaTech LP	None	6 months

Note: PE = pulmonary embolism; DVT = deep venous thrombosis, n/r = not reported; IVC = inferior vena cava; THR = total hip replacement; VTE = venous thromboembolism; GI = gastrointestinal.

^a Unable to anticoagulate.

^b Right IVC filter placement + coil embolization of the caval confluence.

The patient was chronically on warfarin that had to be stopped and a single filter placed in preparation for a cervical laminectomy. Postoperatively, he presented with right lower extremity edema and a CT scan revealed right external iliac vein thrombosis with a duplicated IVC. Fortunately, that particular patient did not have a PE despite the missing IVC. He eventually had another IVC filter placed in the contra-lateral side. The incidence of duplicated IVC is low but careful imaging assessment is mandatory in order to delineate any pertinent anatomic variation that could change the strategy of filter placement and the patient's outcome.

Following the identification of duplicated IVC in a candidate for interruption, 3 options have been reported.⁴⁻¹⁰ Filter insertion in the large IVC and steel-coil embolization of the smaller IVC is one of them.⁴ The simplicity of the method is attractive although it may not prevent the propagation of the thrombus rising from the coiled IVC that may cause renal vein occlusion or recurrent PE. A second option is the placement of a suprarenal IVC filter.^{7,17,18} Greenfield and associates published the largest series where suprarenal placement was accomplished in 71 patients with a follow-up extending to 16 years. The indications for suprarenal filter in that series were patients with

propagating thrombus up to the renal veins, pregnant patients, and women of child-bearing age. Only 26 (37%) patients had imaging follow-up to assess vena cava/filter patency. Of those, no filters were placed in patients with duplicated IVC and the renal function was retrospectively reviewed from records. In a case report of suprarenal filter placement in a duplicated IVC, the authors reported no complications but only short follow-up data available.¹⁸

Finally, the use of bilateral IVC filters has emerged as a simple and safe procedure in patients with duplicated IVC. The placement of bilateral IVC filters has been described in several patients.^{4-6,8-10,16,19-25} The advantage of this approach is that it protects renal veins and prevents recurrent PE. Currently, new retrievable devices are commercially available making feasible temporary placement of dual filters. The available literature on interruption of the duplicated IVC including indications, devices, and follow-up is summarized in Table 1. Noticeable is the poor documentation of follow-up in the majority of the case series. Our patients did not have recurrent VTE, deterioration of the renal function, migration, or fracture of the IVC filters till the last day of follow-up.

Conclusion

Duplicated IVC is an infrequent congenital anomaly that may be present in patients who are candidates for caval interruption. In cases with no other imaging study obtained, selective cavogram is recommended in order to avoid missing IVC and prevent PE.

Three endovascular options have been described. Placement of bilateral IVC filters is a feasible, safe, and may be the preferred technique to minimize the chance of recurrent PE and protect the renal vein from occlusion secondary to propagating thrombus.

Declaration of Conflicting Interests

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