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Case Report

Management of Venous Thromboembolism in a Patient with Duplicated Inferior Vena Cava: A Case Report and Literature Review

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ABSTRACT

Anatomic variations of the inferior vena cava (IVC) are rare, occurring in less than 3% of the population, yet they can pose significant clinical and procedural challenges. We report the case of a 68-year-old male with a contraindication to anticoagulation due to gastrointestinal bleeding, in whom IVC filter placement was indicated for pulmonary embolism prophylaxis. During intra-procedural venography, the patient was found to have a duplicated inferior vena cava (DIVC), a rare vascular anomaly. Bilateral Denali filters were successfully deployed in both IVC limbs to ensure complete thromboembolic protection. This patient remains clinically stable at three-year follow-up with no recurrence of thromboembolism or filter-related complications. This case highlights the placement of bilateral filters in patients with DIVCs that do not converge below the renal veins. Recognizing this was crucial to ensure effective filter placement and avoid incomplete protection against embolism. This case underscores the importance of evaluating venous anomalies prior to interventional procedures involving the IVC. Failure to recognize such variations can lead to technical difficulties, procedural delays, or suboptimal outcomes, including persistent or recurrent thromboembolism. We also review the types of IVC anomalies, their embryology, and some of the potential complications they may cause. Careful procedural planning is essential for optimal patient management.

1. Introduction

Inferior Vena Cava develops from the regression and fusion of the embryonic postcardinal, subcardinal, and supracardinal veins. Anomalies in this process may result in duplication of the IVC [1, 2]. The most common anomaly is sub-renal IVC, with an incidence of 0.2-3% in the general population [3]. Morita further classifies inferior vena cava (IVC) anomalies into several types based on the presence and origin of interiliac venous communications. Type 1 refers to the azygos continuation of the IVC with normal drainage from both common iliac veins (CIVs). Type 2a represents double IVC without any interiliac connection. Type 2b involves a double IVC with an interiliac vein arising from the left CIV to the right IVC, while type 2c features a connection from the right CIV to the left IVC. Type 2d describes an interiliac vein originating from the left internal iliac vein (IIV) to the right IVC, and type 2e involves a connection from the right IIV to the left IVC. These distinctions are important for guiding surgical and interventional strategies [4]. In interventional procedures such as IVC filter placement or retroperitoneal surgeries, unrecognized anomalies can result in recurrent embolism, incomplete filter coverage, or intraoperative hemorrhage. Therefore, careful preoperative assessment and awareness of potential venous anomalies are essential to minimize these complications [5, 6, 7].

We present the case of a 68-year-old male in whom the incidental discovery of a duplicated inferior vena cava during management of gastrointestinal bleeding and recent pulmonary embolism highlights the importance of recognizing rare venous anomalies to guide appropriate intervention.

2. Case presentation

A 68-year-old male with a history of hyperlipidemia, hypertension, and recent pulmonary embolism presented for evaluation of melena and syncope. He had been initiated on apixaban three weeks prior following the diagnosis of a pulmonary embolism. In the days leading up to the presentation, he experienced progressive black, tarry stools and ultimately had a syncopal episode at home.

The patient was afebrile and denied chills, sore throat, nosebleeds, visual changes, cough, leg swelling, abdominal or urinary symptoms, joint pain, rash, numbness, or psychiatric concerns. They reported shortness of breath, chest pain, and a syncopal episode. Vital signs showed a heart rate of 108 bpm, RR 18, temp 98.4°F, and SpO_2 97% on room air. He was found to be hypotensive, and laboratory evaluation revealed a hemoglobin of 9 g/dL, significantly down from baseline.

D-dimers were elevated. X-ray chest was unremarkable; however, CT pulmonary angiography revealed a thrombus in the branch

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Table 1: Clinical Timeline of a Patient with Duplicated Inferior Vena Cava and Acute Venous Thromboembolism

Day	Clinical Summary
Day 1	Presented to ED with syncope and dyspnea; diagnosed with acute PE and bilateral DVTs. He started on apixaban (Eliquis) and was discharged in stable condition.
Day 18	Re-hospitalized due to copious hematemesis, raising concern for upper GI bleed. Anticoagulation was withheld considering suspected active GI bleeding.
Day 20	EGD revealed erosive gastritis without active bleeding. IR consulted for potential IVC filter placement due to anticoagulation contraindication.
Day 21	Digital subtraction venography showed duplicated IVC anatomy; bilateral Denali filters were placed in the infrarenal segments.
Day 22	Hemostasis confirmed; discharged in stable condition with filters placed for ongoing PE prophylaxis.

ED, Emergency Department; PE, Pulmonary Embolism; DVT, Deep Vein Thrombosis; GI, Gastrointestinal; EGD, Esophagogastroduodenoscopy; IR, Interventional Radiology; IVC, Inferior Vena Cava; IVCF, Inferior Vena Cava Filter; IV, Intravenous; PCP, Primary Care Provider.

of the pulmonary artery to the left lower lung lobe as shown in (**Figure 1**). Extensive bilateral thrombi were observed on performing Doppler venous ultrasound of the lower extremity, including femoral, popliteal, and posterior tibial veins of the left leg and common femoral, profunda femoris, femoral, and popliteal veins of the right leg. Anticoagulation was held, and he underwent esophagogastroduodenoscopy, which showed diffuse erosive and ulcerative esophagitis without evidence of active bleeding.

The patient started intravenous proton pump inhibitor therapy and later transitioned to oral pantoprazole. After initial stabilization, apixaban was resumed; however, the patient again developed hypotension and persistent decline in hemoglobin, requiring red blood cell transfusions. Antihypertensive medications were held. Due to concern for ongoing gastrointestinal bleeding and a contraindication to anticoagulation, interventional radiology was consulted for IVC filter placement. The procedure was performed under maximal sterile conditions with local anesthesia. The right common femoral venous access was obtained using ultrasound guidance and a micropuncture system. A 6 French sheath was placed, and a 5 French pigtail catheter was advanced. Digital subtraction venography revealed a duplicated inferior vena cava (IVC). A Denali filter was deployed in the infrarenal segment of the right IVC with satisfactory positioning and no significant tilt.

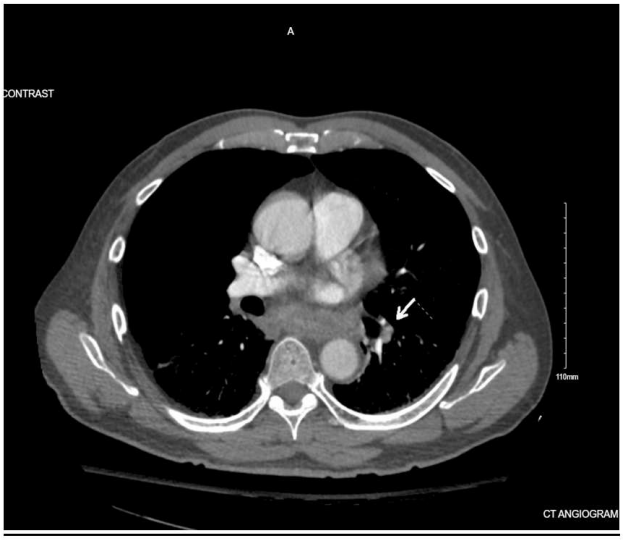


Figure 1: CT Angiogram showing Pulmonary Embolus in the intermediate branch of the pulmonary artery to the left lower lobe (White arrow)



Figure 2: Venography showing duplicated IVC with bilateral filter placement. Morita Type 2b with interiliac communication arising from the left common iliac vein.

Subsequently, the left common femoral vein was accessed similarly. A 6-French sheath and pigtail catheter were used to perform digital subtraction venography, again demonstrating the duplicated IVC. A second Denali filter was deployed in the infrarenal left IVC with appropriate expansion and positioning. Hemostasis was achieved after removal of all devices. The diagnosis of duplicated IVC was made intra-procedurally, as no prior CT venography had been performed. On the other hand, the decision to place bilateral IVC filters as opposed to a unilateral filter was made because of the presence of bilateral DVTs. Also, Denali filters were selected for their retrievability and compatibility with small-caliber veins [8].

Following filter placement and permanent discontinuation of apixaban, the patient remained hemodynamically stable and experienced no further episodes of gastrointestinal bleeding. He was discharged in a stable condition with outpatient follow-up arranged with gastroenterology and primary care.

At follow-up, the patient presented with reported improved shortness of breath, and lower extremity ultrasound showed no thrombus. Repeat EGD revealed healing esophagitis, and he remained

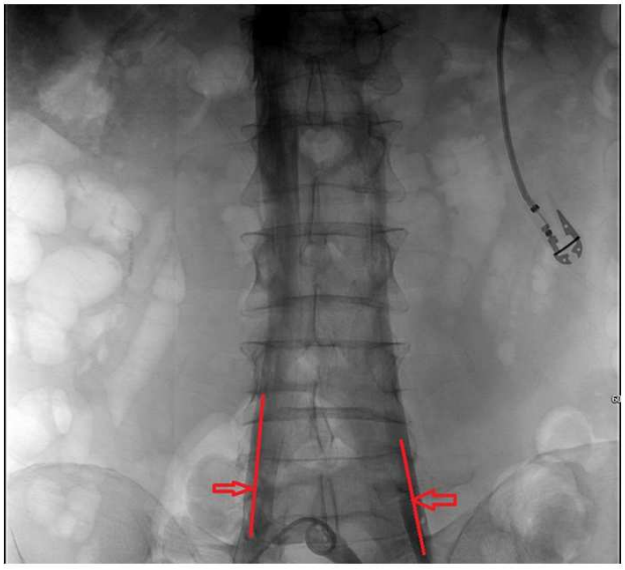


Figure 3: Fluoroscopy showing Bilateral IVCs with filter placement; red arrows indicate duplicated IVCs. Dual filters were placed because of the presence of bilateral DVTs and Morita Type 2b without infra-renal convergence. A single filter in the Right IVC would not be adequate in view of this anatomy.

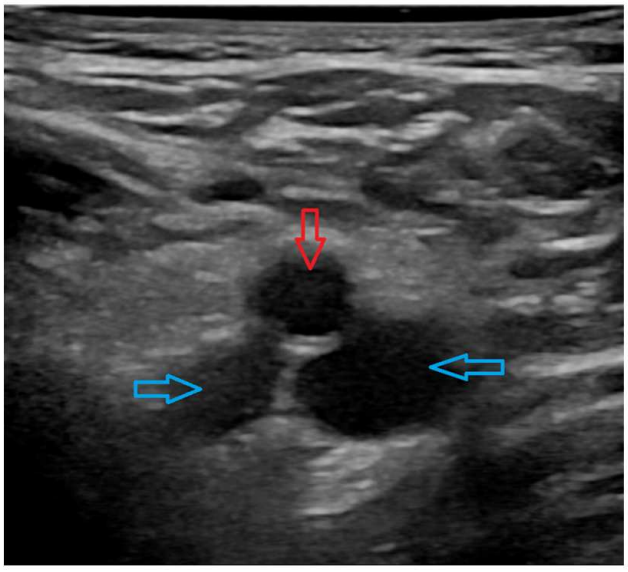


Figure 4: Ultrasound showing duplicated IVCs (blue arrows) and aorta (red arrow). The aorta has a more uniform, circular appearance, while IVCs have a more elliptical, collapsible appearance.

on pantoprazole. Due to recurrent unprovoked PEs, it was decided he needed lifelong anticoagulation. A trial of apixaban was once again attempted but was promptly discontinued after he developed hematemesis. At that time, IVC filters were left inside because of a high-risk history, but the patient was lost to medical follow-up afterwards. He presented to his PCP after about 3 years. He remains clinically stable with no recurrence of thromboembolism or filter-related complications.

3. Discussion

Double Inferior Vena Cava (DIVC) is a rare congenital vascular anomaly with an estimated incidence ranging from 0.2% to 3% [3, 2]. This condition arises due to incomplete regression of the embryonic venous system, specifically the right and left supracardinal veins. During embryological development, these venous structures typically fuse, forming a single IVC. However, when fusion fails to occur, two separate IVCs persist, often running on either side of the aorta and converging near the level of the renal veins. If this convergence does not result in a single venous trunk, a true double IVC develops [1, 3, 2] [9].

Duplicated inferior vena cava is classified into several types based on anatomical differences. In this case, the patient was found to have a duplicated inferior vena cava consistent with Morita type 2b anatomy, characterized by bilateral IVCs with an interiliac venous communication originating from the left common iliac vein (CIV) connecting to the right IVC [4].

In most cases, DIVC is asymptomatic and discovered incidentally, either on imaging or during surgical procedures [10]. Nevertheless, it can carry significant clinical implications, particularly in the context of venous thromboembolism (VTE) and interventional procedures such as IVC filter placement. If a left-sided IVC is unrecognized, it may drain via collaterals into the azygous system, which can bypass a unilaterally placed IVC filter, leading to recurrence, as illustrated in a case report by Malgor et al and others [11, 5, 6, 7].

The 2020 clinical practice guideline by the Society of Interventional Radiology recommends bilateral filter placement in patients with duplicated inferior vena cava (IVC) when the two limbs do not converge below the renal veins, as in our case. This is because placing a filter in only one limb may leave the other venous channel unprotected, allowing thrombus to bypass the filter and reach the pulmonary circulation, supporting bilateral filter placement in our case. The guideline highlights that without bilateral protection, there is a significant risk of recurrent embolic events due to incomplete filtration, making recognition of this anatomical variant essential for effective venous thromboembolism prevention [12].

Selection of the optimal filter strategy should be individualized, considering anatomical details, the relative size of each IVC, and the location and pattern of confluence. Recent case reports emphasize the utility of pre-procedural venography to delineate venous anatomy, guide decision-making, and ensure optimal outcomes [13].

We conducted a review of the literature and identified several case reports that describe various strategies for filter placement in the setting of DIVC. These include placement of a single filter above the confluence of the bilateral IVCs, placement of two separate filters, one in each IVC below the renal veins, or placement of a filter in the dominant IVC, meaning the vessel carrying most of the venous return from the lower extremities. These approaches are summarized in **(Table 2)** [10, 9, 14, 13, 15, 5, 16, 17, 18, 19, 20]. Accurate diagnosis of DIVC relies on imaging, with computed tomography (CT) and venography being the most reliable modalities. These not only confirm the presence of dual IVCs but also clarify their anatomical course and their relationship with adjacent structures such as the renal veins [21].

Importantly, DIVC can pose challenges in retroperitoneal surgery, renal transplantation, and other vascular interventions due to the risk of unexpected hemorrhage or inadvertent injury to anomalous vessels [22, 23, 6, 7]. For example, Habuchi et al. described a

Table 2: Case reports with IVC filter placement in patients with duplicated IVCs

Case number	Reference	Number of Filters	Location
1	Hatmi et al. [10]	1	Suprarenal
2	Lan et al. [13]	1	Left IVC (the culprit vein)
3	Sartori et al. [18]	2	Both IVC
4	Malgor et al. [5]	2	Both IVC
5	Malgor et al. [5]	2	Initially only main IVC. Later, due to recurrent PE, the Left IVC was also discovered on repeat imaging, and a filter was placed there as well.
6	Sinnott et al. [19]	2	Both IVC
7	Lagrotta et al. [14]	1	Right Infrarenal IVC
8	Balawender et al. [9]	2	Both IVC
9	Li et al. [15]	1	Right IVC
10	Li et al. [15]	1	Suprarenal above confluence
11	Oppenheim et al. [16]	2	Both
12	Suzuki et al. [20]	2	Both
13	Patel et al. [17]	2	Both (infrarenal)

IVC, Inferior Vena Cava; PE, Pulmonary Embolism; Suprarenal, above the renal veins; Infrarenal, below the renal veins.

case of renal cell carcinoma that involved the left-sided IVC, necessitating surgical excision of the vessel [24]. Similarly, Wang et al. reported a case in which DIVC caused ureteral obstruction, highlighting the need to consider this anomaly in the differential diagnosis of extrinsic ureteral compression [25]. Given these potential complications, awareness of DIVC is crucial in preoperative planning for retroperitoneal surgeries, and necessary intraoperative adaptations should be made when this vascular variant is present [26]. No specific inferior vena cava (IVC) filter brand is considered universally superior or "the best" according to current clinical guidelines or comparative studies. The American College of Radiology states that multiple retrievable filter designs are available in the United States, with no one design currently considered superior, and device selection should be individualized based on patient anatomy and clinical scenario.[27] Similarly, the National Comprehensive Cancer Network notes that, due to a lack of randomized controlled trials comparing filter types, no particular filter should be considered superior [28].

Comparative studies show that the Denali filter demonstrates favorable technical performance relative to other commonly used retrievable filters. Denali is associated with lower rates of filter tilt and strut penetration compared to Celect and Option filters, as well as shorter fluoroscopy times and lower rates of complex retrievals. For example, Denali had a significantly lower retrieval failure rate and required less use of advanced retrieval techniques than Option and Tulip filters. In prospective multicenter data, Denali exhibited high technical success for both placement and retrieval, with low complication rates and no filter fractures or significant tilt at retrieval [8][29][30, 31, 32].

In summary, no IVC filter brand is considered superior or the best by major guidelines. Still, Denali consistently demonstrates lower complication rates and easier retrieval compared to several other retrievable filters in head-to-head studies.

Though retrievable filters are preferred to minimize long-term complications such as IVC occlusion, many remain in place due to persistent contraindications to anticoagulation, as in this case [12].

4. Conclusion

Duplicated inferior vena cava, a rare congenital vascular anomaly, has vast clinical implications, particularly in patients who require IVC filter placement. In this case, the anatomical variant was incidentally discovered during emergent filter deployment in a patient with active gastrointestinal bleeding and recent pulmonary embolism on anticoagulation. Bilateral filter placement was necessary to ensure complete venous thromboembolic protection.

Limitations of this report include the absence of pre-procedural CT venography, lack of anatomical detail such as confluence level and IVC diameters, and no attempt at filter retrieval, which could have impacted long-term outcomes. Also, this study could not determine procedural costs and radiation exposure. This case underscores the importance of procedural vigilance and the need for interventionalists to be familiar with venous anomalies to prevent inadequate treatment or complications. If unrecognized, duplicated IVC can lead to incomplete filter coverage, placing patients at continued risk for pulmonary embolism in the setting of deep vein thrombosis. Early recognition and individualized filter strategy in DIVC are essential for procedural success and avoiding recurrent embolism in high-risk, anticoagulation-intolerant patients.

Conflicts of Interest

The authors declare that they have no competing interests.

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Informed consent

Consent for publication was obtained from the patient involved in this case report.

Large Language Model

None

Authors Contribution

AJ and ZE contributed to conceptualization, data curation, investigation, resources, writing – original draft, writing – review and editing, visualization, and project administration. FR contributed to writing, including review, editing, and proofreading.

Data Availability

This is a case report. No datasets were generated or analyzed during the preparation of this manuscript. All relevant clinical information has been included within the article itself.

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