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Case Report

Duplicated inferior vena cava filter placement: a case report and review of filtration strategies

Jose Lopez[1]*, Catherine Kilada[1], Tasneem Zahran[1], Amy Chen[2], Ashley Choi[2], Shirley Xue Zhou[2], Anjana Ramesh[2], Martine A. Louis[1], Manikyam Mutyala[1]

[1]General Surgery, Flushing Hospital Medical Center, Flushing NY
[2]New York Institute of Technology College of Osteopathic Medicine, Old Westbury, New York

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***Correspondence:**
Dr. Jose Lopez,
E-mail: jlopez2887@gmail.com

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ABSTRACT

Duplication of the inferior vena cava (IVC) is an uncommon congenital venous anomaly that complicates IVC filter placement because each caval limb can provide an independent route for pulmonary embolization. No consensus exists regarding bilateral infrarenal versus single suprarenal filtration. An 88-year-old man developed an acute ischemic stroke three days after open reduction and internal fixation of an intertrochanteric hip fracture and received tenecteplase. He subsequently developed operative-site and gastrointestinal bleeding with hemorrhagic shock. Duplex ultrasonography demonstrated bilateral calf deep vein thromboses, and active bleeding precluded anticoagulation. During IVC filter placement through left femoral venous access, cavography revealed a duplicated IVC. Two infrarenal filters were deployed, one in each caval limb, without an immediate procedural complication. In a duplicated IVC, a single infrarenal filter may leave the contralateral venous channel unprotected. Bilateral infrarenal filters can provide filtration of both limbs when each has an adequate landing zone. A single suprarenal filter above the confluence is an alternative when infrarenal caliber, thrombus distribution, confluence, or landing-zone anatomy is unfavourable. Cross-sectional imaging and complete cavography are important for defining the anatomy and individualizing device placement. Recognition of duplicated IVC is critical before filter deployment. An anatomy-based strategy may achieve filtration of all relevant venous channels while balancing procedural complexity and device burden.

Keywords: Duplicated inferior vena cava, Inferior vena cava filter, Deep vein thrombosis, Venous thromboembolism, Venography

INTRODUCTION

Duplication of the inferior vena cava (IVC) is a rare congenital anomaly, with an estimated prevalence of 0.2%–3%.[1,2] Most often discovered incidentally on imaging, it results from persistence of the left supracardinal vein during embryologic development.[1,3]

Although typically asymptomatic, this anatomic variant has clinical implications in patients with venous thromboembolism (VTE). In the setting of contraindications to anticoagulation, inferior vena cava filters are commonly used to prevent pulmonary embolism. The presence of a duplicated IVC introduces a unique challenge, as each venous channel may serve as a separate pathway for embolization.[1,4] Failure to recognize this anomaly can result in incomplete protection if a single infrarenal filter is placed, potentially leading to recurrent pulmonary embolism.[1,2] Multiple strategies have been described. There is no established consensus or

guideline for optimal filter placement in patients with duplicated IVC.[4,5] This report describes duplicated IVC discovered during filter placement and reviews the anatomical and technical considerations informing bilateral infrarenal versus single suprarenal filtration.

CASE REPORT

An 88-year-old man presented from home with altered mental status, left-sided weakness, and a fall and was diagnosed with an acute ischemic stroke. Three days before admission, he had undergone open reduction and internal fixation of a right intertrochanteric hip fracture. He received tenecteplase in the emergency department at 16 mg (0.25 mg/kg x body weight) one time dose.

During transfer to the medical intensive care unit, surgical-site bleeding with dependent ecchymosis and episodes of melena were noted. The patient became hypotensive and required vasopressor support for hemorrhagic shock. His hemoglobin changed from 7.7 g/dl to 5.3 g/dl, and he received blood products and other hemostatic treatment. Computed tomography demonstrated an expanding right hip hematoma, and duplex ultrasonography demonstrated acute deep vein thrombosis in the bilateral gastrocnemius and right soleal veins. Therapeutic anticoagulation was contraindicated because of active operative-site and gastrointestinal bleeding.

Vascular Surgery was consulted and taken to the operating for IVC filter placement in the setting of recent tenecteplase administration, acute bilateral calf deep vein thromboses, and ongoing surgical and gastrointestinal hemorrhage. Because of the right hip operation and associated hematoma, venous access was obtained through the left common femoral vein under ultrasound guidance using a 4-French micropuncture needle. Cavography demonstrated two patent infrarenal caval channels connected inferiorly by an interiliac communicating vein. The communication permitted catheter passage from the left common femoral and iliac venous system into the right-sided IVC.

The persistent left IVC drained superiorly into the left renal vein, while the right IVC continued cephalad toward the right atrium. Because both caval channels provided potential pathways for emboli, bilateral infrarenal filtration was selected to provide protection across the duplicated venous system. Two Option ELITE retrievable vena cava filters (Argon Medical Devices, Plano, Texas) were deployed, one in each infrarenal IVC below the corresponding renal venous inflow.

Post-deployment fluoroscopy demonstrated satisfactory positioning of both filters. The sheath was removed, and hemostasis was achieved with manual compression. The patient tolerated the procedure without immediate complication and was transferred to the medical intensive care unit in stable condition.

DISCUSSION

Duplicated inferior vena cava (IVC) is an uncommon congenital venous anomaly, with a reported prevalence of approximately 0.2–3%, arising from persistence of the left supracardinal vein during embryologic development.[1-3] Although frequently asymptomatic and incidentally discovered, this anatomic variant becomes clinically significant in the context of venous thromboembolism (VTE), particularly when mechanical prophylaxis is required due to contraindications to anticoagulation. In such cases, failure to recognize a duplicated IVC may result in incomplete caval filtration and subsequent pulmonary embolism (PE), as each limb can serve as an independent conduit for emboli.[1,2,4]

A central finding of this review is the absence of standardized guidelines for IVC filter placement in patients with duplicated IVC. Current management strategies are largely derived from case reports, small case series, and retrospective analyses, resulting in considerable heterogeneity in clinical practice. Across the literature, three principal approaches have been described: bilateral infrarenal filter placement within each IVC limb, single suprarenal filter placement above the confluence of the duplicated system, and selective placement in a dominant limb with adjunctive techniques such as coil embolization of the contralateral channel or interiliac communication.[1,2,4,6-8] The choice among these strategies is influenced by several factors, including vessel diameter, symmetry of the duplicated system, location and extent of thrombus, and operator experience.

The principal strategies reported in the literature are summarized in Table 1. These approaches have not been compared prospectively; therefore, selection should be guided by individual anatomy and clinical circumstances.

Bilateral infrarenal filter placement is most commonly employed when both IVC limbs are well-developed and of comparable caliber. In this scenario, each limb represents a separate embolic pathway from the lower extremities, and placement of a single infrarenal filter may leave the contralateral limb unprotected. Multiple reports have demonstrated effective embolic protection with dual filters, with low rates of immediate complications.[4,6,7] However, this approach is associated with increased procedural complexity, longer operative time, higher cost, and greater device burden. Additionally, bilateral placement may not always be technically feasible in cases of small-caliber vessels or challenging venous access.

In the present patient, bilateral infrarenal placement was selected because cavography demonstrated two patent, small-caliber infrarenal caval channels without thrombus or stenosis. The persistent left IVC drained into the left renal vein, while the right IVC continued cephalad connected inferiorly by an interiliac communicating vein. Although exact diameters and landing-zone lengths were

not recorded, each channel contained an adequate patent infrarenal segment below its corresponding renal venous inflow for filter deployment. This anatomy provided two technically suitable and separately accessible landing zones.

Table 1: Reported filter-placement strategies in duplicated inferior vena cava anatomy.

Strategy	Potential anatomical setting	Potential advantages	Limitations
Bilateral infrarenal filters	Two patent limbs of sufficient caliber with adequate infrarenal landing zones	Addresses both potential embolic pathways while avoiding suprarenal placement	Requires two devices; greater cost, procedural complexity, and retrieval burden
Single suprarenal filter	Unfavorable infrarenal caliber or landing zones, proximal thrombus, asymmetric limbs, or anatomy suitable for filtration above the confluence	Single-device strategy that covers both duplicated channels	Requires careful assessment of renal-vein anatomy and suprarenal device considerations
Selective limb filtration with adjunctive embolization	Selected asymmetric systems or an expendable contralateral channel/interiliac communication	May avoid bilateral filter placement in carefully selected anatomy	Added procedural complexity and limited supporting evidence

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In contrast, suprarenal IVC filter placement provides a single-device solution that can protect against emboli originating from both venous channels. This approach is particularly advantageous in patients with asymmetric duplicated systems, small or hypoplastic infrarenal limbs, high confluence of the IVC trunks, or thrombus extending to or above the level of the renal veins.[5,8,9] Suprarenal placement is also preferred in cases of external compression of the infrarenal IVC, renal vein thrombosis, or when an adequate infrarenal landing zone is not available.[5,8]

Historically, suprarenal filter placement was associated with concerns regarding increased risk of filter migration, fracture, renal vein thrombosis, and potential renal dysfunction. However, more recent studies have challenged these assumptions. Contemporary data demonstrate that suprarenal filters are both safe and effective, with low complication rates, minimal risk of migration, and no significant impact on renal function.[5,8,10] In a retrospective analysis of suprarenal IVC filters, there were no cases of clinically significant PE, no meaningful changes in renal function, and a 100% technical success rate of filter retrieval when attempted.[8] These findings support the use of suprarenal placement as a viable and often advantageous alternative when infrarenal placement is not feasible or would result in incomplete protection.

An additional consideration is the potential relationship between duplicated IVC anatomy and the development of VTE. Several studies suggest that anomalous venous anatomy may predispose patients to thrombosis due to altered flow dynamics, including venous stasis and impaired venous return.[3,11] This may partially explain the frequent association between duplicated IVC and extensive or recurrent deep vein thrombosis observed in reported cases. Consequently, these patients often present with more complex thrombotic disease, further emphasizing the need for individualized treatment strategies. A consistent theme across the available reports is the importance of accurate pre-procedural and intra-procedural anatomical assessment. Cross-sectional CT or MRI may identify caval duplication, renal-vein relationships, thrombus extent, and potential landing zones. Complete cavography at the time of intervention provides direct mapping of both channels and may reveal anatomy not recognized on prior imaging.[1] In reported cases, unrecognized duplication has resulted in placement of a single infrarenal filter that leaves the contralateral pathway unprotected, emphasizing the need to confirm complete caval anatomy before deployment.[1,2,4]

Despite the growing body of case-based evidence, the literature remains limited by the absence of prospective studies, randomized trials, or large comparative analyses evaluating suprarenal versus infrarenal strategies specifically in patients with duplicated IVC. Most available data are derived from single-case reports, case series, or small institutional experiences, which limits generalizability and contributes to variability in practice. Additionally, differences in filter types, operator technique, and follow-up duration further complicate

direct comparison of outcomes. Taken together, these findings suggest that management of duplicated IVC in the setting of VTE should be highly individualized, with careful consideration of anatomical characteristics, thrombus distribution, and technical feasibility. Rather than a single preferred approach, the optimal strategy is one that ensures complete embolic protection while minimizing procedural risk and complexity.

This report has important limitations. It describes a single patient, and the available literature consists predominantly of case reports, small series, and retrospective studies. The two principal strategies have not been directly compared, so this case cannot establish the superiority or comparative safety of bilateral infrarenal versus single suprarenal filtration.

CONCLUSION

Duplicated inferior vena cava represents a rare but clinically important anatomic variant that significantly impacts the management of venous thromboembolism. Current evidence demonstrates that there is no standardized approach to IVC filter placement in this population. Both bilateral infrarenal and single suprarenal strategies have been successfully described, but the available evidence is insufficient to establish the superiority of either approach. Bilateral infrarenal filters may be considered in patients with two suitable caval limbs, whereas suprarenal placement offers a single-device alternative when infrarenal anatomy or thrombus distribution is unfavorable. Accurate delineation of the duplicated venous anatomy using available cross-sectional imaging and complete intra-procedural cavography is central to selecting a strategy that filters all relevant venous channels. Given the current reliance on case reports and retrospective studies, further research is needed to establish standardized guidelines and determine the optimal management strategy for patients with duplicated IVC.

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