

# A unique case of hypoplastic inferior vena cava leading to bilateral iliofemoral venous outflow obstruction and review of literature

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## ABSTRACT

Venous thromboembolism (VTE) is a common cardiovascular disease associated with high rates of morbidity and mortality whereas it induces substantial health care costs and increased use of resources. The current standard of treatment for acute deep vein thrombosis (DVT) is anticoagulation, although revascularization can be considered in younger patients with severe symptoms and extensive thrombus burden to prevent long-term sequelae of VTE (eg, recurrent DVTs, post-thrombotic syndrome post-pulmonary embolism syndrome, and chronic thromboembolic pulmonary hypertension). A rare cause of VTE is anomalous development of the inferior vena cava (IVC) and can challenge endovascular revascularization. This case report describes a case of hypoplastic supra hepatic IVC, associated with distal IVC occlusion and bilateral lower extremity DVTs treated successfully with suction thrombectomy and on table only thrombolysis, avoiding the higher risk for major bleeding, intensive care unit admission and prolonged hospitalization associated with prolonged tissue plasminogen activator infusion. (*J Vasc Surg Cases Innov Tech* 2022;8:842-9.)

**Keywords:** Hypoplastic IVC; IVC anomalies; Deep venous thrombosis; DVT; Suction thrombectomy

Anomalous embryologic inferior vena cava (IVC) development is seen in approximately 4% to 5% of patients younger than 30 years with a diagnosis of deep vein thrombosis (DVT), with an estimated prevalence of 0.0005% to 1.0000% in the general population<sup>1,2</sup> and has been associated with several contemporary visceral abnormalities, including situs inversus, dextrocardia, anomalies of the spleen.<sup>3</sup> Nonetheless, DVT with or without an associated pulmonary embolism constitutes the most common manifestation of this rare clinical entity.<sup>4</sup> Venous thromboembolism (VTE) is a complex, multifactorial disease, involving interactions between acquired and inherited prothrombotic states.<sup>5-7</sup>

In general, VTE affects 1 per 1000 adults annually, accounts for more than 250,000 hospital admissions per year, and is associated with a mortality rate of 60,000 to 100,000; associated health care costs are estimated at \$5 to \$8 billion.<sup>8-10</sup> Long-term complications include post-thrombotic syndrome (PTS), post-pulmonary embolism syndrome, and chronic thromboembolic pulmonary

hypertension that could significantly limit patients' quality of life.<sup>11</sup> The current standard of therapy for acute DVT involves anticoagulation with thrombolysis (either systemic or catheter directed) with or without revascularization procedures reserved for extensive thrombus and phlegmasia.<sup>12</sup>

More recent studies suggest the use of minimally invasive mechanical or suction or aspiration thrombectomy to prevent PTS and long-term complications, is a reasonable first treatment approach for younger patient with extensive thrombus.<sup>13</sup> Nonetheless, endovascular revascularization could be challenged significantly in cases of anomalous development of the IVC. We present a case of hypoplastic suprahepatic IVC complicated with distal IVC occlusion and bilateral common iliac vein DVTs, treated endovascularly with suction thrombectomy, and summarize the current literature on suction and aspiration thrombectomy.

## CASE REPORT

**Patient characteristics.** A 26-year-old female patient presented with moderate right lower extremity swelling up to the thigh level, associated with worsening back pain that started approximately 1 week earlier. The patient had history of eosinophilic esophagitis and Hashimoto's thyroiditis, and she was on oral contraceptives for birth control. Patient had positive family history of DVTs and pulmonary embolisms, although no genetic coagulopathy was identified. Venous duplex ultrasound showed noncompressible veins in the right upper thigh, with poor visualization of the proximal iliac veins. Further imaging with computed tomography venography demonstrated extensive thrombosis of the suprahepatic and distal IVC and bilateral common iliac veins, with extension of the thrombus into the

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Author conflict of interest: none.

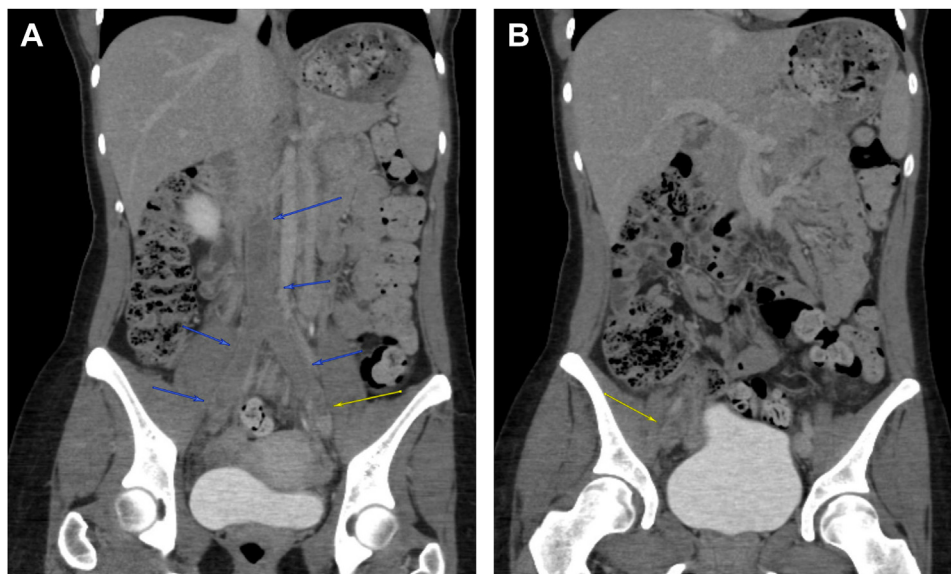
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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

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<https://doi.org/10.1016/j.jvscit.2022.10.010>



**Fig 1.** Computed tomography venography demonstrated extensive thrombosis of the suprahepatic and distal inferior vena cava (IVC) and bilateral common iliac veins (**A**; blue arrows), with extension of the thrombus into the internal and external iliac and common (**B**; yellow arrows), superficial and deep femoral veins all the way to the right proximal thigh.

right internal and external iliac and common, superficial and deep femoral veins all the way to the right proximal thigh (Fig 1). The patient was placed initially on continuous systemic heparin infusion with a target activated partial thromboplastin time range of 60 to 90. Informed consent was obtained from the patients for treatment and publication of these case reports and accompanying images. No protected health information was disclosed. No institutional review board approval was required.

**Endovascular technique.** Vascular access was obtained under ultrasound guidance on the right superficial femoral vein with a micropuncture needle. A 4F sheath was advanced and a 0.035" stiff Glidewire Terumo was placed to the ipsilateral iliac vein. The 4F sheath was exchanged for an 8F sheath, and then a crossing catheter and Glidewire were advanced into the IVC. Systemic heparin was given throughout the case to maintain an active clotting time of more than 200 seconds, which is our goal for the majority of DVT cases treated endovascularly. On-table thrombolysis was performed with 4 mg of tissue plasminogen activator. Then the sheath was exchanged for an 11F sheath under standard procedures and a Penumbra CAT 12 Lightning Aspiration System (Penumbra, Inc., Alameda, CA) was advanced to the ipsilateral iliac vein and distal IVC (Fig 2). After multiple passes were performed, the previously occluded suprahepatic retro hepatic and suprahepatic IVC was crossed and additional suction thrombectomy was performed (Fig 3).

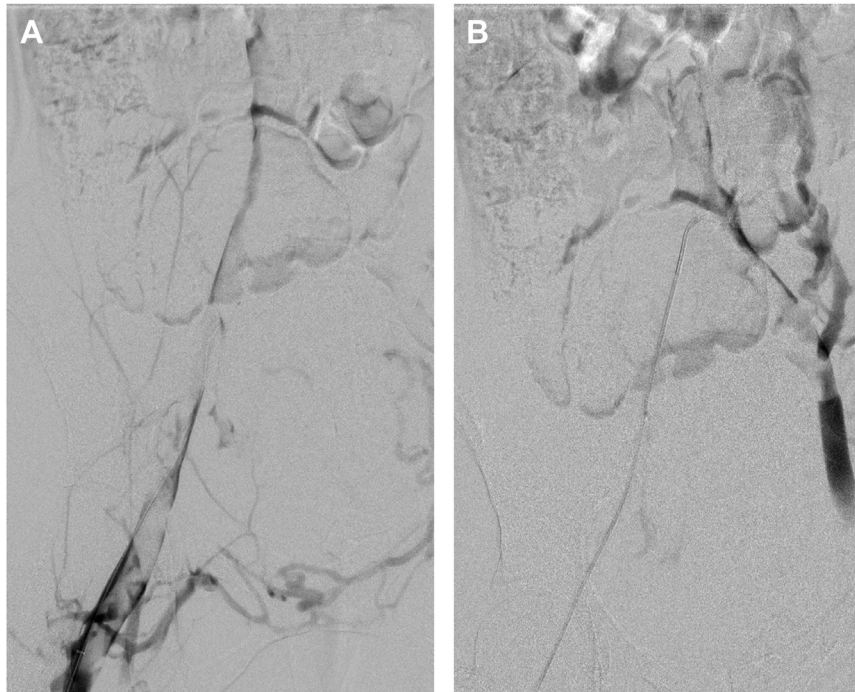
Residual stenosis at that segment was treated with serial balloon inflations of 10- and 12-mm high-pressure balloons, eventually establishing adequate outflow toward the right heart (Fig 4). Then, with a Sos Omni flush catheter, the guidewire was advanced up and over to the contralateral superficial femoral vein. The Indigo catheter was also tracked up and over and

suction thrombectomy of the left iliofemoral venous outflow system was performed (Fig 5). Areas of residual stenosis at the common and external iliac veins were treated with inflation of a 12-mm balloon to nominal pressure. Given that this was a young female patient wanting to become pregnant in the future and taking into consideration the onset of symptoms as well, which suggested acute thrombus, no stents were placed during this procedure to avoid stent-related complications and spare this option for potential future reinterventions.

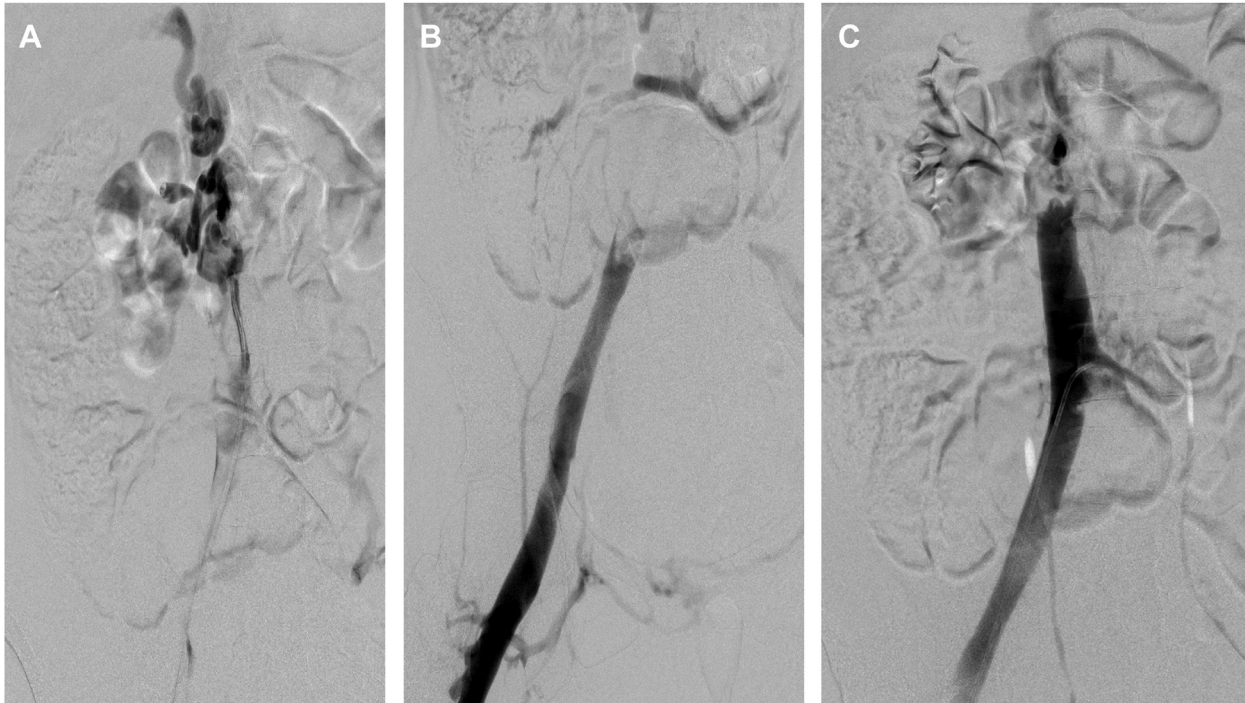
A completion venogram demonstrated near total thrombus removal bilaterally (Fig 6). The estimated blood loss was 500 mL. The procedure was terminated; however, the sheath was left in place for systemic heparin infusion. It was removed the next day at the bedside, and the patient was discharged to home on full dose of anticoagulation with rivaroxaban for at least 6 months, and 20- to 30-mm Hg compression stockings were prescribed. Also, it was recommended to avoid oral contraceptive pills completely and use an alternative method for birth control. No perioperative complications were observed. The patient reported immediate relief of her symptoms after the procedure and a repeat venous ultrasound examination failed to show any lower extremity DVTs at the office 1 month after the index procedure. The patient was instructed to follow up at 6 and 12 months in the clinic for surveillance ultrasound examination and to continue anticoagulation.

## DISCUSSION

Congenital anomalies of the IVC including hypoplasia and/or agenesis of the infrarenal IVC constitute a rare clinical condition and the underlying pathogenetic mechanisms remain unclear,<sup>7,14</sup> most likely attributed to both inherited and acquired etiologic factors.<sup>15</sup> Most



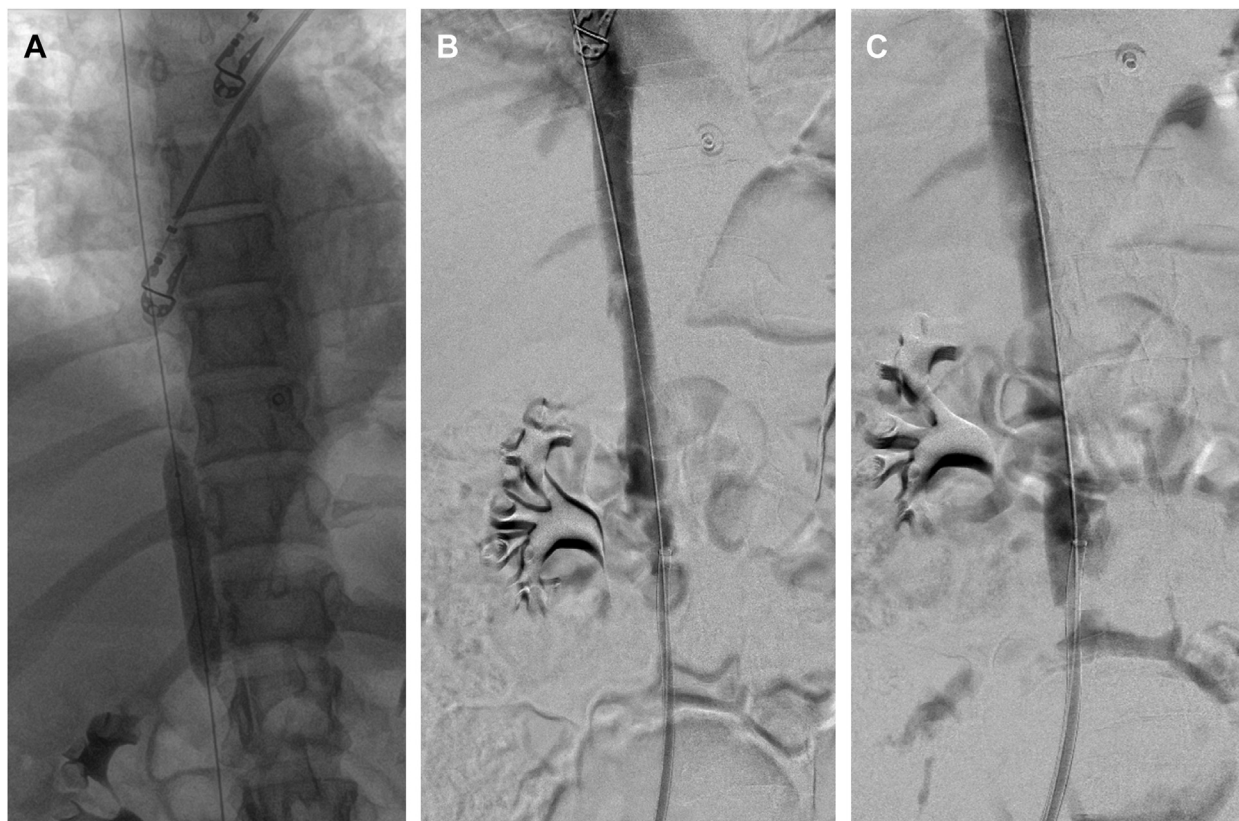
**Fig 2.** Diagnostic venogram demonstrating extensive thrombus burden in the distal inferior vena cava (IVC) and bilateral iliac veins (**A, B**) with extension of the thrombus into the right internal and external iliac and common femoral veins (**A**).



**Fig 3.** (**A-C**) The previously occluded suprahepatic inferior vena cava (IVC) was crossed and additional suction thrombectomy was performed establishing some outflow toward the heart.

of the patients with hypoplastic or atretic IVC are asymptomatic and therefore this condition remains unrecognized in many cases.<sup>16</sup> Nonetheless, when symptomatic

the typical presentation includes isolated DVTs at the iliofemoral segments<sup>16</sup> and associated symptoms owing to venous congestion is collateral pathways (eg, lower



**Fig 4. (A-C)** Residual stenosis at the inferior vena cava (IVC) was treated with serial balloon inflations of 10- and 12-mm high-pressure balloons, eventually establishing adequate outflow toward the right heart.

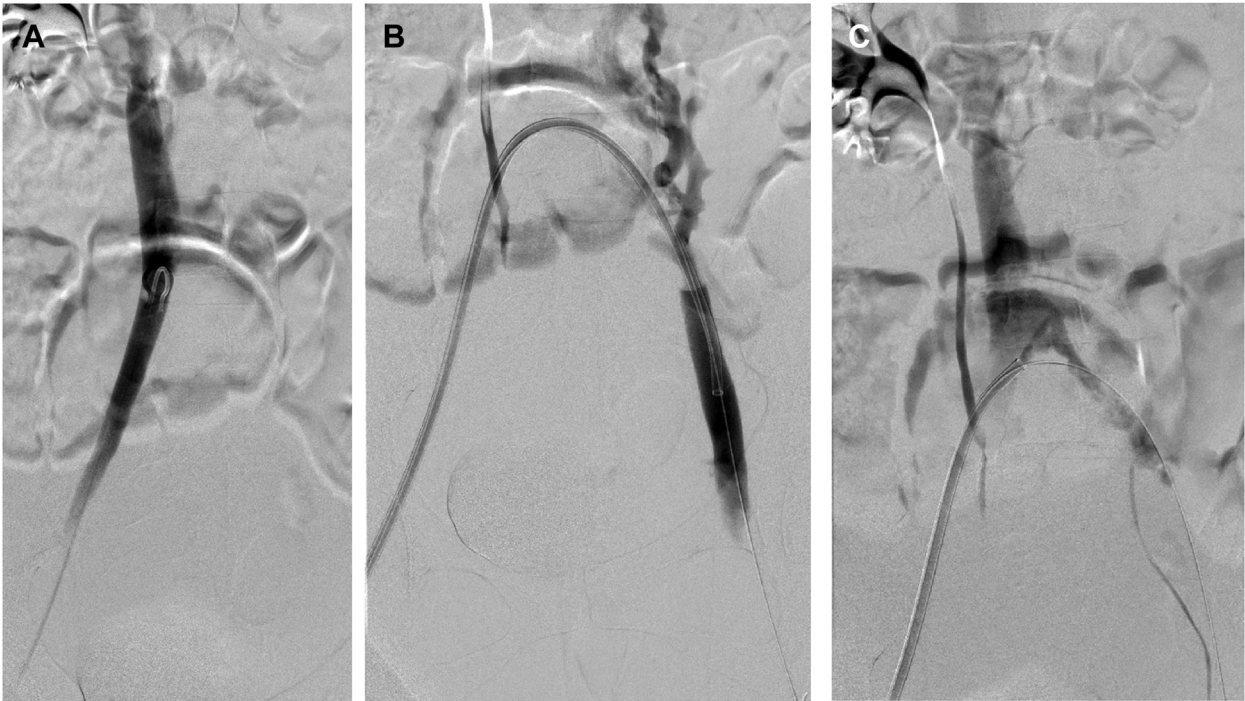
back or extremity pain from nerve root compression, abdominal discomfort related to gonadal venous system, etc).<sup>17-19</sup>

Although there are no clinical trials to determine the best treatment approach for DVTs associated with IVC anomalies, therapeutic anticoagulation is considered the best approach, similar to any acute DVT, with most experts recommending life-long anticoagulation owing to the irreversible nature of this clinical entity.<sup>16,20</sup> Although conservative management with anticoagulation and compression stockings could control symptoms in many cases, venous thrombectomy is believed to prevent further deterioration and worsening of venous congestion in the collateral pathways in cases of acute iliofemoral DVTs and severe symptoms, followed by balloon angioplasty and/or stenting in cases of residual stenosis or poor acute luminal gain after the thrombectomy.<sup>12,16,21</sup>

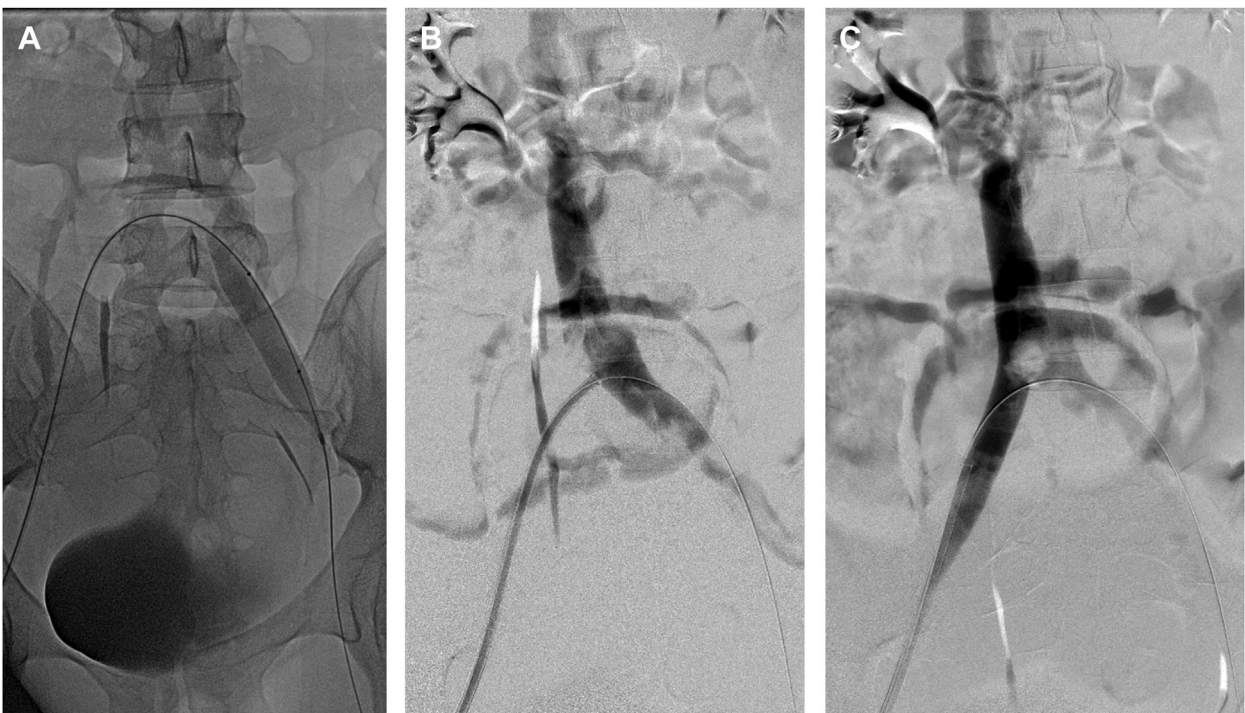
Thrombolysis and major reconstructive surgeries have also been described as potential treatment options; however, the risk for bleeding and high recurrence rate associated with thrombolysis and the high morbidity and mortality rates associated with open procedures, constitute these interventions less attractive for both patients and physicians.<sup>20,22</sup> This case report of a young female patient with a hypoplastic suprahepatic IVC and

associated infrarenal and bilateral iliofemoral DVTs demonstrates that suction thrombectomy with or without on-table thrombolysis is a feasible and reasonable treatment approach, avoiding the risks (eg, major visceral bleeding, intracranial hemorrhage) and costs (eg, intensive care unit admission, repeated procedure in the operating room) associated with prolonged thrombolysis, offering immediate relief of symptoms.

Although not exclusively for patients with hypoplastic IVC, recent studies have demonstrated that early endovascular thrombectomy of lower extremity DVTs could decrease the risk of PTS and post-DVT sequela.<sup>23-30</sup> The [Table 1](#) summarizes contemporary studies reporting on the outcomes of thrombolysis-free suction or aspiration endovascular thrombectomy for with acute and sub-acute lower extremity. No clinical trials including patients with IVC hypoplasia or atresia and contemporary iliofemoral DVTs were identified with head-to-head comparisons among the several treatment approaches (ie, anticoagulation vs thrombolysis vs revascularization techniques). However, based on our experience, suction thrombectomy is feasible and could be a safe and effective treatment approach for acute iliofemoral DVT in the setting of hypoplastic IVC for symptomatic patients, significantly decreasing the thrombus burden and thrombus-related long-term sequelae.



**Fig 5. (A, B)** The guidewire was advanced up and over to the contralateral superficial femoral vein with an Omni flush catheter and **(C)** then suction thrombectomy of the left iliofemoral venous outflow system was performed.



**Fig 6. (A, B)** Areas of residual stenosis at the left common and external iliac veins were treated with inflation of a 12-mm balloon to nominal pressures. **(C)** Completion venogram demonstrated near total thrombus removal bilaterally.

## CONCLUSIONS

Endovascular suction thrombectomy without conventional thrombolysis can be considered a safe and

effective treatment option for symptomatic patients with hypoplastic IVC and associated iliofemoral DVTs, limiting the risk of bleeding and promising favorable

**Table 1.** Studies investigating the outcomes of thrombolysis-free suction or aspiration thrombectomy for iliofemoral DVT

Study, year	Patients, N	Study design	Population	Age (mean)	Thrombectomy modality	Demographics	Anti-thrombotic therapy and adjunctive modalities	Thrombolysis	Follow-up (mean)	Main results	Conclusion
Robertson et al, 2022	16	Single-center, retrospective caseseries	Iliofoemoral acute DVT	58.6 yrs	Penumbra 12 system	75% female, swelling pain at presentation, 25% current PE, 50% smoking, 25% diabetes, 5 prior DVT, 2 oral contraceptive use	therapeutic anticoagulation in all pts, adjunctive procedures: x1 CDT, x8 stenting, x10 angioplasty	Only in 1 pt	2.7 mo	>70% thrombus resolution in all pts, single-session therapy for 15 of the 16 pts, median blood loss was 155mL, no periprocedural complications	Catheter-aided mechanical aspiration thrombectomy is safe and effective for pts with acute iliofoemoral DVT, minimizing blood loss
Lopez et al, 2019	10	Single-center, retrospective cohort study	Iliofoemoral or central acute DVT	43.8 yrs	Penumbra 8 system with/without manual thrombus maceration	50% male, 5 May-Thurner syndrome, indication for treatment: 4 DVT, 3 stent thrombosis, 1 recurrent DVT, 1 IVC narrowing from IgG4 disease, 1 IVC obstruction from liver tumor invasion	anticoagulation in all pts, angioplasty, stenting, CDT only when aspiration thrombectomy was unsuccessful	Only in 3 pts	3 mo	60% had >70% thrombus removal, 3 of the remaining 4 pts underwent CDT, no bleeding complications, 1 minor PE, 1 severe headache, 2 recurrent DVT	Aspiration thrombectomy can be considered for the treatment of acute iliofoemoral and central DVT with the potential advantage of definitive treatment in one setting
Gedikoglu et al, 2017	9	Retrospective cohort study	Acute and subacute iliofoemoral DVT	29.7 yrs	aspiration thrombectomy using large bore (7-9F) guiding catheters	Pregnant female pts (5 in the 1 <sup>st</sup> , 2 in the 2 <sup>nd</sup> and 2 in the 3 <sup>rd</sup> trimester of pregnancy), massive swelling and pain of the leg at presentation, 77.8% lesion on the left side, 22.2% lesion on the right side, 4 pts acute DVT, 5 pts acute & subacute DVT	anticoagulant treatment in all pts	Not used	3 mo	All pts had complete or significant thrombus removal and uninterrupted venous flow at first intervention, 7 pts experienced immediate complete relief of leg pain, 2 pts had recurrent thrombosis	US-guided aspiration thrombectomy can be considered safe and effective for pregnant women with acute and subacute iliofoemoral DVT
Chung et al, 2016	21	Retrospective cohort study	Subacute DVT of the lower extremity	64.6 yrs	manual rotational thrombus maceration injecting heparin and aspiration thrombectomy via an 11F introducer sheath	8 male & 13 female pts, mean age of the thrombosis was 21.5 days, 2 malignancy-related, 12 May-Thurner	anticoagulation, angioplasty, maceration, provisional stenting	Not used	10.2 mo	Technical & clinical success was 90.5%, mean procedure time was 86 minutes, 2 had additional balloon angioplasty of the femoral vein, 13 had additional iliac vein stenting, 1 unexplained gastrointestinal bleeding	Single-session mechanical thrombectomy is feasible and effective even for pts with aged DVT of the lower limb more than 10 days old
Kwon et al, 2016	106	Retrospective cohort study	Acute iliofoemoral or femoro-popliteal DVT with/without IVC extension	59.8 yrs	aspiration thrombectomy using large bore (8-9F) introducer sheath	Male/female: 30/76, 88 May-Thurner syndrome, 27 DVT with IVC extension	placement of IVC filter & anti coagulation, balloon angioplasty & provisional stenting	Not used	N/R	43% had a trapped thrombus in the filter, among 27 pts with DVT extension into the IVC: 74.1% showed a trapped thrombus in the filter, among 79 pts without DVT extension into the IVC: 32.9% showed a trapped thrombus in the filter	Thrombus migration is common during aspiration thrombectomy in pts with acute DVT of the lower limb
Cakir et al, 2014	42 (21 in each treatment group)	RCT	Acute proximal iliofoemoral-popliteal DVT	51 yrs in ITG vs 59 yrs in MTG	aspiration thrombectomy using large bore (9F) guiding catheter in the ITG group	ITG: male/female: 16/5 vs MTG: male/female: 13/8	ITG: percutaneous aspiration thrombectomy & anticoagulant therapy with/without angioplasty, stenting and IVC filter placement vs MTG: anticoagulation therapy alone	Not used	12 mo	Venous patency rates were 57.1% & 4.76% in the ITG and MTG respectively, 4 PE in MTG vs 1 PE in ITG	Percutaneous aspiration thrombectomy with/without stenting is superior to anticoagulant treatment alone, aspiration thrombectomy can be used as first-line treatment in proximal DVT

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Table 1. Continued.

Study, year	Patients, N	Study design	Population	Age (mean)	Thrombectomy modality	Demographics	Anti-thrombotic therapy and adjunctive modalities	Thrombolysis	Follow-up (mean)	Main results	Conclusion
Park et al, 2014	74	Retrospective cohort study	Acute and subacute lower extremity DVT	64 yrs	manual rotational thrombus maceration injecting heparin and aspiration thrombectomy using a modified 11F introducer catheter	Male/female: 23/51, 65 May-Thurner syndrome, 6 malignancy related, 3 pelvic mass, lower extremity swelling and tenderness at presentation	Aspiration thrombectomy, rotational thrombus maceration & anticoagulant therapy with/without IVC filter placement, angioplasty, stenting if needed	Not used	6 mo (data available in 26 pts)	93.2% had clinical success, technical success was 89.2%, no procedure-related complications	Single-session aspiration thrombectomy is feasible with acceptable outcomes in pts with acute and subacute lower extremity DVT

*CDT*, Catheter-directed thrombolysis; *DVT*, deep vein thrombosis; *ITG*, interventional treatment group; *IVC*, inferior vena cava; *N/R*, not reported; *RCT*, randomized clinical trial; *MTG*, medical treatment group; *PE*, pulmonary embolism.

outcomes with near total thrombus removal. However, further studies with a long follow-up are needed to help determine the most optimal treatment approach for patients with hypoplastic or atretic IVC and associated extensive iliofemoral DVTs, given that the underlying pathophysiologic mechanisms and associated risks may be different than iliofemoral DVTs without IVC anomalies.

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Submitted Sep 26, 2022; accepted Oct 17, 2022.