Galician medical journal 2023
Vol. 30, Issue 2, E202328
DOI: 10.21802/gmj.2023.2.8

Case Report | Internal Medicine

"What IVC?": Deep Vein Thrombosis in the Context of IVC Dysgenesis

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Abstract

Among young, otherwise healthy adults with unprovoked deep vein thrombosis (DVT), uncommon causes like variation in the normal sequential development of the inferior vena cava (IVC), must be explored. Anomalous IVC conditions are estimated to occur in up to 9% of the general population, with the rarest anomaly being IVC agenesis at 0.0005% - 1% general population prevalence. DVTs are more likely to develop in this population due to venous stasis from decreased venous return, even with the formation of extensive collateral veins. Herein, the authorial team presents a 22-year-old patient with leg pain and swelling who was found to have acute DVT, and, incidentally, the absence of the suprarenal IVC with a robust collateral system on further imaging studies. The morbidity of DVTs in this population is very high, and attention should be given to young patients who present with new-onset DVT in the setting of normal coagulation studies and lack of personal or family history of clotting disorders, as the need for specialized imaging such as venograms is necessary to secure the proper diagnosis.

Keywords

Inferior Vena Cava; Radiological Findings; Deep Vein Thrombosis; Anatomical Deviation; Case Presentation; Scoliosis; Iliac Vein Compression

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Introduction

Congenital aplasia or acquired atrophy of anatomical structures within the human physiology is not overall uncommon and often features anatomical compensation [1–3]. This deviation in standard structure often impacts a patient's quality of life [1–3]. Within this case study, a patient presented with deep vein thrombosis (DVT), revealing the absence of the inferior vena cava (IVC). The clinical team worked to understand the epidemiology of this condition, its impact on the patient's life, and the best treatment for this rare case.

Case Presentation

The patient, a 22-year-old male, presented to the emergency department with left-sided inguinal pain and left leg pain, most prominent in the upper thigh. The patient described pain quality as a heaviness that was aggravated by movement, with radiation down his left lower extremity to the level of the left popliteal fossa. Pain onset was approximately nine days before presentation, while the patient was performing resistance training exercises. He endorsed using pre-workout energy mixes, but denied the use of selective hormone supplements, anabolic steroids, illicit drugs, or tobacco. His social history was significant for electronic cigarette use, heavy alcohol use on weekends, and use of *Cannabis sativa*. The patient also reported a new onset of foamy urine within the preceding weeks. His only other medical history was scoliosis and appendectomy. Family history was pertinent for a mother who experienced spontaneous abortions.

On physical examination, the patient demonstrated reproducible pain by palpation of the left thigh and the in-

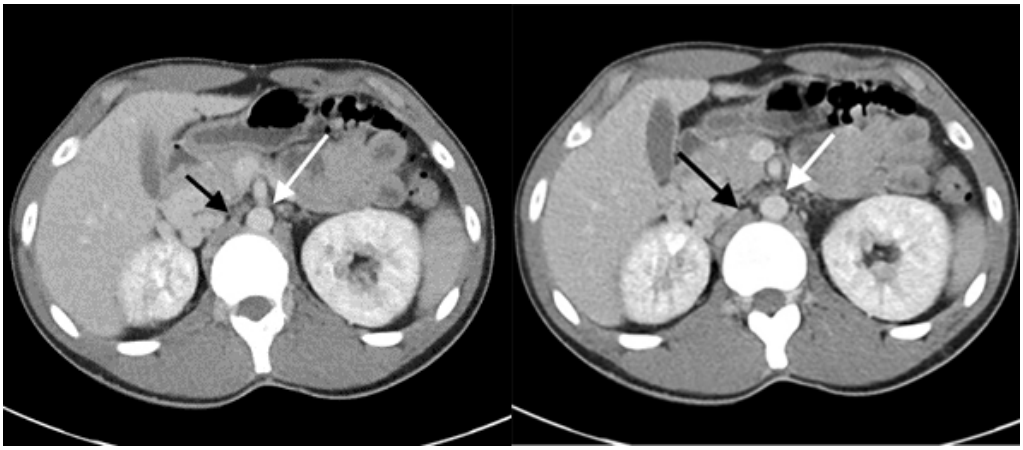

Figure 1. Axial CT venogram of the abdomen showing the absence of the suprarenal IVC (the black arrow). The white arrow demonstrates the abdominal aorta.

guinal region, increased pain with motion of the left hip, and swelling of the left lower extremity down to the popliteal fossa. The remainder of the physical examination was within normal limits. Homan's Sign was not performed in this case due to its low sensitivity and specificity [4, 40–42].

Laboratory Testing and Imaging Studies

Laboratory workup included a complete blood count, comprehensive metabolic panel, urinalysis with reflex microscopy, urine drug screen, and coagulation studies were ordered. Pertinent findings included an elevated prothrombin time (17.6 sec), an elevated urine protein (30 mg/dL), and a positive result for cannabis on the urine drug screen. Due to the risk of a concurrent COVID-19 infection, a well-known and well-described cause of DVT or muscular injury [20–22], the patient was administered a rapid COVID-19 PCR nasopharyngeal test, which was negative.

Due to a high index of suspicion for DVT, a venous duplex ultrasound was ordered, which revealed an extensive occlusive thrombus within the left common femoral vein as well as the proximal and mid portions of the femoral vein. Due to the patient's scoliosis, iliac vein compression, commonly known as May-Thurner syndrome, was suspected and a computed tomography (CT) venogram was ordered. Although the patient was not found to have iliac vein compression, this imaging study demonstrated that the patient lacked a normal suprarenal IVC and that DVT extended to the external iliac vein (Fig. 1, 2). Based on imaging, the IVC terminated at the T12 vertebral level, and the left testicular vein was intact draining into the IVC at the level of the L2 vertebra. The bilateral renal veins entered the IVC at the level of the L1 vertebra. There was a hepatic section seen on imaging that was intact which allowed for flow from the liver to the right atrium; however, it appeared to be an enlarged hepatic vein rather than a portion of the missing IVC. The imaging also demonstrated multiple small venous collaterals throughout the retroperitoneum and pelvis.

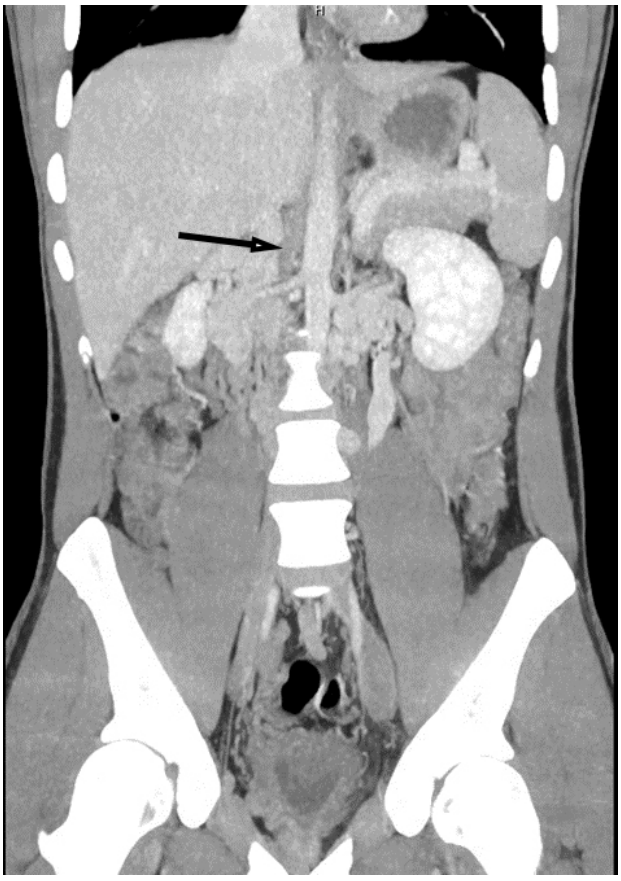

Figure 2. CT venogram coronal view with the black arrow demonstrating the absence of IVC adjacent to the abdominal aorta at the T12 vertebral level.

Treatment

The patient was determined to have a Hamburg Classification truncular subtype (obstructive/narrowing) venous malformation and was started on therapeutic anticoagulation with intravenous heparin infusion to treat DVT. The hematology/oncology team, who were consulted to assist with further treatment, suggested an interventional radiology consult for thrombectomy, which was subsequently per-

formed without significant complications the following morning. This thrombectomy was performed in order to prevent growth of the thrombus and potential occlusion of any collaterals which may have been compensating for the missing IVC. An incision was made in the left-sided popliteal vein and a catheter was placed utilizing the standard method. The thrombus was vacuum suctioned out of the femoral vein and fluoroscopic technique was utilized to demonstrate the now patent vein and its level of reperfusion. Repeat imaging during the procedure (Fig. 3) demonstrated that the patient had a well-developed retroperitoneal collateral system, terminating in either the hemiazygos/azygos system or hepatic portal system. Both the hematology/oncology and interventional radiology teams recommended lifelong oral anticoagulation to prevent future DVTs. Recanalization was not performed due to fears that the patient may re-occlude the new IVC and due to the large amount of peripheral vascularization, so this was deemed to be unnecessary for his care.

Further history taking demonstrated that the patient's elevated aspartate transaminase (AST) was due to heavy weekend drinking, and he was advised to limit alcohol consumption to the recommended 2-3 drinks maximum during a single sitting [6]. Finally, the patient's elevated urine protein was further evaluated with a urine protein to creatinine ratio, which was within normal limits. Within three days of his admission, his urine protein fell within normal limits, raising suspicion that the original abnormal value may have been from increased creatine-powder ingestion from the patient's pre-workout drink mix. Thus, no further intervention was pursued.

The patient's symptoms of thigh pain and swelling continued to improve and the patient was discharged with a prescription for apixaban, a coagulation factor Xa inhibitor, and outpatient follow-up appointments with both hematology/oncology and his primary care provider. The apixaban prescription was dosed at 10 mg twice daily for the first seven days to bring the level of medication to therapeutic levels quickly, and then lowered to 5 mg twice daily from day eight forward to maintain therapeutic anticoagulation. The patient had a thorough work-up in the outpatient setting with hematology, including coagulation studies and autoimmune work-up, all of which were unremarkable. The symptoms of leg swelling and pain decreased over time with the use of apixaban until he was pain free.

Pathophysiology

DVT in this patient was caused by mechanical or anatomical stasis of the blood flow secondary to the absence of an IVC and concurrent increased levels of protein from creatinine supplement consumption. In one case published in 2022 and two cases published in 2014, increased creatine and protein supplementations were found to be the cause of venous thromboembolism (VTE) secondary to dehydration [37–39]. This, along with his malformation, per the authorial team's thought process, was the perfect storm for the development of DVT. Although not seen in this case, one of the most common mechanical causes of venous

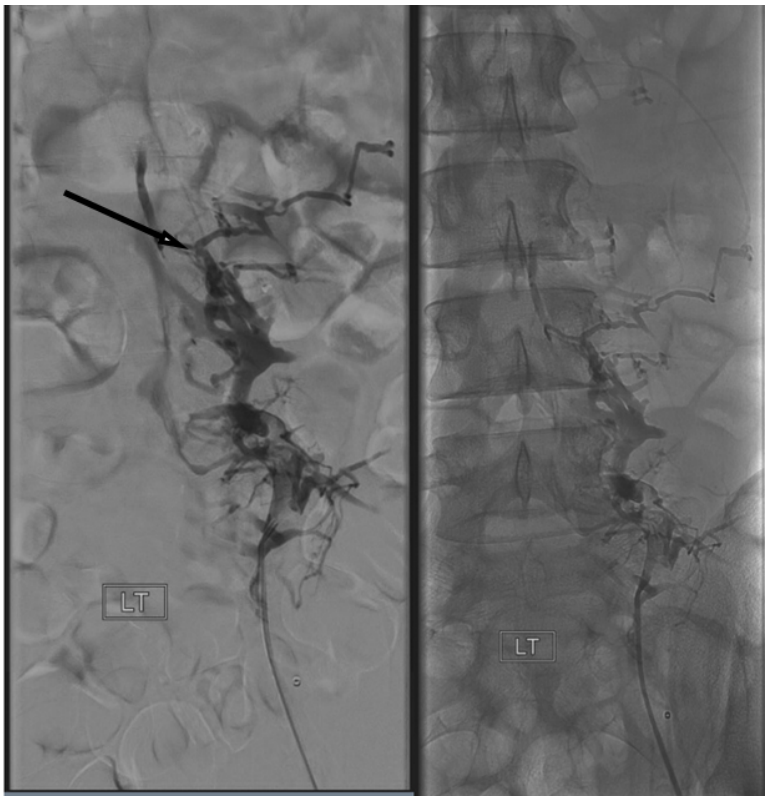

Figure 3. A filling defect from the right-sided external iliac vein and some of the collateral flow of blood back to the systemic circulation. The arrow is located at the end of the venous flow forward in the iliac vein as the remainder of the dye ran off into the collateral systems.

stasis is that of iliac vein compression, or May-Thurner Syndrome, which is characterized by the left common iliac vein being compressed by the overlying right common iliac artery [7, 8]. With a female predominance, the prevalence of iliac vein compression anatomy is estimated to be up to 20% of the general population, with most cases being asymptomatic [23]. Some studies have noted that this estimate may increase up to 50% in cases of thrombosis of the iliofemoral vein, suggesting that it may be an underdiagnosed condition [10].

It is estimated that up to 50% of patients with DVT may have diagnosable thrombophilia, or other hypercoagulable condition of either congenital or acquired etiology; often factor V Leiden or prothrombin G20210A [13, 14]. Normally, factor V is involved in the conversion of prothrombin to thrombin, and when mutated, protein C is unable to inhibit factor V, therefore resulting in hypercoagulability [15]. Prothrombin G20210A is a genetic defect, with adult patients who are autosomal heterozygous or homozygous for the defective gene having an increased risk of developing clinically significant thrombosis [16].

Any variation of the normal sequential development of the IVC can result in a defect, which contributes to the constellation of possible congenital IVC anomalies [10]. Some of these IVC abnormalities include retroaortic left renal vein, left IVC, circumaortic left renal vein, and absent infrarenal IVC [30]. Among young, otherwise healthy adults with unprovoked DVTs, anomalous IVC conditions are estimated to be between 5.3% and 9.5% [17, 28, 29]. Of this population, agenesis is one of the rarest possible IVC anomalies, with one estimate being between 0.0005% to 1% of the general population, though approximations vary considerably between studies [11]. In addition to congenital causes, some suggest that thrombotic developments during the perinatal period may also give rise to IVC aplasia [12]. As either IVC thrombosis after intrauterine development or congenital agenesis could be the main contributory factor leading to the patient's venous malformation, it is difficult to ascertain the underlying cause of this patient's condition.

Discussion

Diagnosing DVT was relatively straightforward due to the high index of clinical suspicion. While testing for the causes of DVTs in an inpatient setting might have been tempting, it was deferred as it would likely not alter the patient's treatment. In addition, in the acute setting, with the use of heparin or direct oral anticoagulants (DOACs), these particular test results may not be representative of the patient's true coagulation values [32–36]. These two major practices, when used in tandem, are known as value-based care, or performing tests only based on what will change clinical practice and taking into consideration the cost for the patient [24]. As value-based care was the primary approach to the patient's treatment, the exact cause for patient's IVC atresia was not explored during his admission.

While proteinuria in the context of lower extremity pain may cause concern for a nephrotic-induced thrombus formation, this was not the case. Through contextually specific questions in history taking, the team concluded that proteinuria was most likely secondary to increased intake from creatinine-protein supplements rather than from nephrotic syndrome; a theory supported by the resolution of proteinuria within two days of discontinuing protein supplements.

This case is unique in the literature in that it showcased a relatively healthy young male, who presented acutely with lower extremity DVT and was found to have a rare absence of the suprarenal IVC. One case series of 35 patients with IVC atresia reported the median age to be 40 years, with 26 of them presenting with DVT [31]. This highlights the need to consider IVC atresia as a differential diagnosis in the young patient with DVT. The absence of his suprarenal IVC and the subsequent development of the collateral venous drainage system demonstrates the body's ability to adapt to environmental challenges, both intrinsic and extrinsic. This anatomical deviation and compensation are not uncommon and similar findings have been found in several other vascular structures to a lesser extent [1–3].

Conclusions

IVC agenesis is one of the rarest IVC anomalies at 0.0005% - 1% general population prevalence. In patients younger than 30 years old who present with DVT, the rate of a co-existing IVC anomaly is around 5%. The morbidity of IVC anomalies is high, with the development of bilateral DVTs estimated to be present in over 50% of cases. Due to this, special attention must be paid to unprovoked DVTs in this subset of patients, as typical imaging with ultrasound would not detect an IVC anomaly.

Ethical Statement & Informed Consent

All procedures described in this case report were performed in accordance with the ethical standards of the Helsinki Declaration (2013) and with the patient's informed consent. Patient permission was obtained before writing the case report. Since then, further contact with the patient has been lost and attempts to contact the patient for over a year have not been successful. This manuscript is anonymized in order to protect the identity of the patient described.

Data Availability

The clinical, laboratory, and imaging data used in this case report are available from the corresponding author upon reasonable request. Due to privacy concerns, access to the data will be subject to obtaining permission from the patient or legal guardian and signing a data use agreement. Please contact corresponding author for more information.

Conflict of Interest

Thomas C. Varkey: Thomas is faculty with the Colangelo College of Business at Grand Canyon University and receives a paycheck for his instruction with the University, is faculty with the National MS Society's Fellows monthly difficult case webinar, and sits on the editorial board of ProClinS Cardiology. Other authors declare that there are no

financial or personal relationships that could have inappropriately influenced the work presented in this manuscript. The manuscript was presented at The Arizona American College of Physicians conference in 2022, The Ross University School of Medicine's 65th Research Day Symposium in 2022 and The National American College of Physicians Meeting in 2023.

Financial Disclosure

The authors declared no financial support.

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Received: 2023-01-15

Revision Requested: 2023-03-01

Revision Received: 2023-04-10

Accepted: 2023-04-12