Thrombolysis in May-Thurner Syndrome and Iliofemoral DVT: An Illustrative Case and Narrative Review of the Literature

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Submitted: 27 July 2020. **Accepted:** 1 December 2020. **Published:** 28 July 2021.

DOI: <https://doi.org/10.22374/cjgim.v16i3.480>

Abstract

Post-thrombotic syndrome (PTS) describes residual leg swelling, pain, and venous insufficiency that persists after acute deep vein thrombosis (DVT). PTS occurs in 40 to 60% of patients and contributes significantly to patient morbidity and healthcare costs. Despite standard therapy including anticoagulation, early ambulation, and compression stockings. PTS is more common in iliofemoral DVT. Despite conflicting evidence, there has been increasing use of endovascular therapies such as thrombolysis, thrombectomy, and venous stenting to reduce the incidence of PTS. May-Thurner Syndrome (MTS) is a significant risk factor for the development of iliofemoral DVT and PTS because of the compression of the left common iliac vein by the overlying right common iliac artery. The main objective is to review the evidence for endovascular management of iliofemoral DVT using MTS as an illustration of a patient population that may benefit from this therapy. Currently, endovascular therapies are not the recommended routine management of nongangrenous iliofemoral DVT. But can be considered in exceptional cases, such as MTS or other compressive syndromes, for obtaining venous patency and potentially prevent severe PTS.

Resume

Le syndrome postphlébitique (SPP) correspond à un œdème résiduel des jambes, à de la douleur et à une insuffisance veineuse qui persiste après une thrombose veineuse profonde (TVP) aiguë. Il survient chez de 40 à 60 % des patients et contribue grandement à la morbidité du patient et aux coûts en soins de santé, malgré les traitements classiques comprenant l'anticoagulothérapie, l'ambulation précoce et les bas de contention. Le SPP est plus fréquent dans les cas de TVP iliofémorales. Malgré des données probantes contradictoires, on utilise de plus en plus les traitements endovasculaires comme la thrombolyse, la thrombectomie et la mise en place d'endoprothèses veineuses pour réduire la fréquence du SPP. Le syndrome de May-Thurner (SMT) est un facteur de risque important de l'apparition d'une TVP iliofémorale et du SPP en raison de la compression de la veine iliaque commune gauche par l'artère iliaque commune droite contre le plan vertébral. Le

principal objectif consiste à examiner les données probantes relatives à la prise en charge endovasculaire de la TVP iliofémorale en utilisant le SMT pour illustrer une population de patients qui pourrait bénéficier de ce traitement. À l'heure actuelle, on ne recommande pas les traitements endovasculaires dans la prise en charge courante de la TVP iliofémorale non gangréneuse, mais dans des cas exceptionnels, comme le SMT ou autres syndromes de compression, ils peuvent être envisagés pour obtenir une perméabilité veineuse et prévenir les cas graves de SPP.

Highlights and Learning Points

1. Anticoagulation in the treatment of DVT aims to stop thrombus progression, prevent embolization, and reduce and prevent long-term sequelae of DVT such as PTS and chronic thromboembolic pulmonary hypertension.
2. PTS is a common and serious long-term complication of DVT.
3. Secondary analyses of the CaVenT, ATTRACT, and CAVA trials show a reduction in moderate-to-severe PTS and faster resolution of DVT symptoms with large iliofemoral clots when catheter-directed thrombolysis is used.
4. Most patients with nonlife or limb-threatening DVT, including iliofemoral DVT, should initially be offered anticoagulation alone, without endovascular management (catheter-directed thrombolysis, thrombectomy, and venous stenting).
5. Endovascular management of DVT is only recommended after a trial of anticoagulation in select patients with iliofemoral DVT, severe symptoms, a low risk of bleeding, and risk factors for severe PTS.

Introduction

Deep vein thrombosis and post-thrombotic syndrome

Deep vein thrombosis (DVT) affects over 35,000 Canadians each year and most commonly occurs in the proximal leg veins, with iliofemoral DVT ranging between 4.4 to 25% of all cases.^{1,2} Therapeutic anticoagulation is the standard treatment for DVT and prevents thrombus extension and embolization and reduces the long-term sequelae of DVT.³ Despite treatment with therapeutic anticoagulation, use of compression stockings, and early ambulation, up to 40–60% of patients develop post-thrombotic syndrome (PTS).^{3,4} PTS includes several symptoms, like residual leg swelling, pain, chronic venous insufficiency, and, in severe cases, venous ulceration.^{5, 6} The severity of PTS is measured using the Villalta score, which considers the patient's symptoms and clinical signs of venous insufficiency. Mild PTS is more common than moderate or severe PTS but is still associated with a poor quality of life, as measured by the quality of life questionnaires comparable with other chronic diseases, such as arthritis, diabetes, and obstructive lung disease.^{4,6} The ineffectiveness of traditional therapies for PTS has necessitated the investigation of endovascular management, particularly for iliofemoral DVT, where PTS occurs more commonly. The incidence of PTS is higher in proximal than distal DVT with the strongest overall predictor for PTS being thrombus location (2.23 increase in Villalta score for iliofemoral venous thrombosis vs. calf venous thrombosis [95% confidence interval, 1.29–3.16]).^{4,6} Additional risk factors for the occurrence of PTS include increasing body-mass index (0.14 increase in Villalta score per 1 kg/m² increase), older age

(0.3 increase in Villalta score per 10-year increase in age), previous ipsilateral DVT, and female sex, among others.⁴

May-Thurner syndrome (MTS)

MTS is an anatomical variant resulting in left common iliac vein obstruction by the right common iliac artery (Figure 1). It is a significant risk factor for iliofemoral DVT and PTS.⁷ Despite initial treatment with therapeutic anticoagulation, recurrence of DVT because of venous compression is increased by 73%.⁸ A recent publication of the Japanese ATOMIC registry reported that venous stenting in 59 MTS patients reduced the recurrence rate of DVT to 8% in those with adequate follow-up, and only 3% of patients developed mild PTS.⁹

Options for endovenous management

The traditional approach of anticoagulation alone is ineffective in treating iliofemoral DVT as venous patency is often not restored and can result in recurrent thrombosis, PTS, and venous hypertension.^{10,11} However, systemic thrombolysis is avoided in the management of iliofemoral DVT as it is associated with an increased risk of bleeding.^{10,11} These difficulties in treating iliofemoral DVT and preventing PTS has led to the increasing interest in endovascular approaches, including catheter-directed thrombolysis (CDTL), pharmaco-mechanical thrombolysis (PMT), and venous stenting.^{2,10,11} The theoretic advantage of endovascular approaches is quick degradation of the thrombus and return of venous patency.¹¹ According to the 'open-vein hypothesis,' early recanalization and stenting should maintain

Figure 1. Venogram illustrating left common iliac vein obstruction by compression from the right common iliac artery, consistent with May-Thurner Syndrome.

venous patency and theoretically reduce both venous reflux and the incidence of PTS.¹²

CDTL is the delivery of a thrombolytic agent directly to the thrombus via an infusion catheter positioned within the vein and is the most commonly used endovenous therapy for DVT.¹¹ CDTL allows high local thrombolytic drug concentrations but reduces the systemic effects of the agent.¹¹ PMT is commonly performed with CDTL and involves mechanical thrombus removal using various techniques and devices.¹¹ It can be delivered using rotating motorized systems, rheolytic instruments, and ultrasound-enhanced devices.¹¹ There are unique advantages of the combination of PMT and CDTL, such as reduced required doses of thrombolytic agents, increased rates of complete clot resolution, and shorter treatment times.¹¹ Following CDTL and PMT, venous stenting is often performed as an adjunct therapy in cases where there are persistent obstructive lesions, venous stenosis, or increased venous pressure.¹¹

Illustrative Case for the Use of Endovenous Management

We present a case of a 38-year-old female presented to the emergency department with a six-day history of isolated left leg

edema and pain with no personal or family history of DVT. She was on oral contraception (levonorgestrel 0.10 mg and ethinyl estradiol 0.02mg) for the preceding 6 months and had a 3-hour flight 2 weeks before presentation. She was a lifelong nonsmoker.

On examination, the patient was normotensive (blood pressure, 127/95 mmHg) and mildly tachycardic (heart rate, 104 beats/minute) with a respiratory rate of 20 breaths per minute and oxygen saturation of 100% on room air. She appeared to be in pain. Cardiovascular, respiratory, and abdominal examination was unremarkable. Her entire left leg was edematous, warm, and erythematous when compared with her right leg. Her left calf measured 39 cm, while her right calf measured 37 cm. Motor and sensory functions of the lower limbs were intact bilaterally. Bilateral femoral, popliteal, dorsalis pedis, and posterior tibial pulses were observed in the Doppler ultrasound, with no clinical features of ischemia.

Routine investigations included a hemoglobin of 132 g/L, platelet count of 225×10^9 /L, creatinine of 71 μ mol/L, INR of 1.1, aPTT of 35 seconds, and serum β -hCG <1 IU/L. An abdominal and pelvic contrast computed tomography scan demonstrated extensive thrombus within the left superficial femoral, common femoral, external iliac, and common iliac veins with extension into the distal inferior vena cava. A venogram, performed to assess for interventional therapy, confirmed left femoral vein thrombosis (Figure 2). There was a compression of the left common iliac vein by the right common iliac artery consistent with MTS.

The patient underwent successful PMT with the aspiration of large quantities of clot roughly 12 hours after presentation. A Cragg-McNamara catheter was inserted, and an initial 5 mg bolus of recombinant tissue plasminogen activator (rTPA) was administered, followed by a continuous infusion of rTPA initiated at a rate of 2 mg/hour. Heparin was infused separately through the side port of the catheter and adjusted according to the standard nomogram.

Repeat venography was performed at 12, 24, and 48 hours. The rTPA infusion was increased to 4mg/hour at 12 hours and 5mg/hour at 24 hours because of extensive persistent residual thrombosis. Later was decreased to 4 mg/hour, then to 2mg/hour, and discontinued after 60 hours when venography showed clot dissolution with the improved flow (Figure 3). Repeat venography 10 hours after discontinuing rTPA showed a patent and thrombus-free left venous system with confirmed indentation of the left common iliac vein by the right common iliac artery (consistent with MTS).

A 12×42 mm bare-metal stent was deployed across the left common iliac vein stenosis. There was successful percutaneous transluminal angioplasty of the inferior vena cava (IVC) of up to 10 mm. Venography post procedure showed good flow within

Figure 2. Preintervention venogram demonstrating extensive thrombus within the left femoral vein.

both iliac venous systems and into the IVC. No immediate local complications and no evidence of bleeding.

The patient was discharged on dalteparin 200 units/Kg and enteric-coated aspirin 81mg daily. She discontinued her oral contraceptive pill. On 1 month follow-up, the patient reported complete symptom resolution, and her legs were equal in size. Ultrasound with doppler showed no evidence of left leg DVT. So, the dalteparin and aspirin were replaced with rivaroxaban 20 mg once daily till the end of her therapy. The patient was clinically well without DVT recurrence, the development of PTS, or major clinical bleeding for the last 7 years. We contribute this patient's recovery and postthrombotic course to the combination of PMT and CDTL followed by venous stenting. The PMT and CDTL restored venous patency, and the endovenous stent maintained venous flow and prevented DVT recurrence because of continued compression of the left common iliac vein by the right common iliac artery.

Figure 3. Repeat venography showing complete clot dissolution after administration of recombinant tissue plasminogen activator before stenting.

Review of the Evidence for Endovenous Management of DVT

Evidence for CDTL in the management of DVT

The Norwegian CaVenT study demonstrated a clinically significant reduction in mild-to-severe PTS with CDTL in high proximal DVT.¹³ This small randomized controlled trial (n=209) examined the incidence of PTS following catheter-directed rtPA with anticoagulation versus standard anticoagulation alone for above-thigh DVT affecting the femoral vein, isolated pelvic deep vein, or combined iliofemoral veins. PTS was measured using the validated Villalta scale and was defined with a score of 5/33 or higher. The addition of CDTL to standard anticoagulation resulted in a 14% absolute risk reduction (95% confidence interval [CI], 0.2–27.9) in PTS and an absolute benefit increase of 18.5% in venous patency when compared with anticoagulation alone.

In 2017, the ATTRACT study aimed to validate the findings of the CaVenT trial and investigated the use of mechanical thrombectomy by aspiration or maceration following CDTL.¹⁴ This trial included 692 patients at 56 centers across the United States with randomization to CDTL/PMT and subsequent

anticoagulation versus anticoagulation alone. Venous stenting was advocated if the lesions caused 50% or higher narrowing of the vein diameter. PTS was defined as ulceration secondary to index DVT or a Villalta score of at least 5/33 (5–9, mild; 10–14, moderate; 15+, severe). There was no difference in overall PTS or DVT recurrence between the two groups at 24 months, yet the intervention group suffered more major bleeding in the first 10 days than anticoagulation alone (1.7% vs. 0.3%; $P = 0.049$). A subgroup analysis for iliofemoral DVT demonstrated a statistically significant reduction in both moderate and severe PTS (RR, 0.73; 95% CI, 0.54–0.98), as well as improvement in venous-disease specific quality of life at 24 months ($P = 0.029$), for those randomized to intervention.¹⁵ This benefit was not observed for those with femoral-popliteal DVTs.¹⁶

Most recently, the Dutch CAVA trial (2019) randomized 184 patients exclusively with iliofemoral DVT to ultrasound accelerated CDTL versus standard anticoagulation.³ Again, venous stents were advocated in compressive syndromes, such as MTS, or those with a venous diameter narrowing of 50% or more. PTS was defined as a Villalta score of at least 5/33 (5–9, mild; 10–14 moderate; 15+, severe). Similar to the ATTRACT study, there was no significant difference between groups for the development of overall PTS at 1 year (odds ratio [OR], 0.75; 95% CI, 0.38–1.5) or recurrent DVT (OR, 1.23; 95% CI, 0.32–4.78). However, in contrast, to ATTRACT, CTDL was not associated with a significant increase in major bleeding.

The results of the ATTRACT and Dutch CAVA trial differ from the earlier TORPEDO trial (2010), where percutaneous endovenous intervention consisting of thrombectomy, balloon venoplasty, stenting, and local thrombolytic therapy with anticoagulation was compared with anticoagulation alone.¹⁷ This study enrolled 169 patients and reported reduced development and severity of PTS as well as decreased recurrence of VTE at 6-month follow-up than anticoagulation alone, similar to the findings of the ATTRACT iliofemoral subgroup analysis and the CaVenT trial. As with the Dutch CAVA trial, the increase in the risk of bleeding with the percutaneous endovenous intervention was not significant.

Despite the increasing use of interventional modalities for iliofemoral DVT, the evidence remains uncertain regarding the long-term benefit for PTS and DVT recurrence. While there was initial promise for PTS reduction with the use of CDTL in the TORPEDO and CaVenT trials, the larger ATTRACT and CAVA studies demonstrated no benefit of CTDL for the overall reduction of PTS and came with an associated increased risk of bleeding compared with anticoagulation alone.^{3,13,14,17}

Smaller, secondary analyses of these trials, however, do show trends toward benefit for a reduction in moderate-to-severe PTS and faster resolution of DVT symptoms with large iliofemoral clots.^{3,14} The results of the TORPEDO, CaVenT, ATTRACT, and CAVA trials are shown in Table 1. It is important to note that participants, investigators, or analysts were not blinded in these studies, introducing the possibility of bias in the analysis and reporting of results. The nature of the intervention makes blinding challenging in these trials, and potential bias was minimized with objectively measured outcomes.

Evidence for venous stents in the management of DVT

The goal of venous stenting is to maintain venous patency and prevent PTS. But the majority of patients with DVT do not have an underlying persistent risk factor that necessitates stenting.¹⁸ Venous thrombolysis and stenting are therefore not the standard of care for most patients with DVT of any size/location, with the most recent American College of Chest Physicians' guidelines recommending against this practice except in exceptional situations.¹⁸ However, patients with MTS, other compressive syndromes such as Nutcracker syndrome (compression of the left renal vein by the abdominal aorta or superior mesenteric artery), or chronic venous stenosis may benefit from thrombolysis and stenting.^{13,14,19}

There is a lack of consensus concerning the use of venous stents following the restoration of patency despite multiple studies (Table 2) showing the use of venous stents following CDTL to be safe and effective in maintaining venous recanalization.^{17–21} Additionally, while baseline differences in population demographics preclude direct comparisons, the rates of PTS following stenting in the ATOMIC registry were numerically lower than documented rates from the larger CaVenT, ATTRACT, and CAVA trials. However, these trials are of varying quality (differences in sample size, duration of follow-up, and reported outcomes) and often did not report the long-term clinically relevant outcomes such as PTS or recurrent DVT. The risks associated with venous stenting include stent migration, stent occlusion, stent fracture, and bleeding. Complications are rare and in appropriately selected patients do not outweigh the potential benefits.^{9,19,20,21} The Canadian guideline on the use of venous stents was published in 2015. Since then, multiple studies have been published, necessitating a review of the literature and the creation of up-to-date guidelines.¹

Table 1. Summary of Trials Comparing Anticoagulation with Endovascular Management to Anticoagulation Alone in Acute DVT

Reference	Type of study	Intervention and control	Number of patients	Outcome				Result (efficacy and safety)
Notten et al. ³	Multicentre, randomized, single-blind, allocation-concealed, parallel group, superiority trial	Intervention	Intervention	PTS at 12 Months (measured by Villalta score > 5 or venous ulceration)	29%	P = 0.42	Odds ratio (95% CI), 0.75 (0.38–1.50)	Catheter directed thrombolysis did not significantly reduce the risk for PTS or recurrent DVT after 1 year. There was no significant increase in major bleeding with catheter directed thrombolysis compared with anticoagulation alone.
		Control	Control		35%			
Enden et al. ¹²	Randomized control trial	Intervention	Intervention	PTS at 24 Months (measured by Villalta score > 5 or venous ulceration)	41%	P = 0.047	Absolute risk reduction (95% CI), 14.4% (0.2%–27.9%)	CDTL and anticoagulation significantly decreased the occurrence of PTS at 24 months compared with anticoagulation alone. There were 20 bleeding complications (19.8%) in the intervention group, including three major and five clinically relevant bleeds and no bleeding complications in the control group.
		Control	Control		55%			
Vedantham et al. ¹⁴	Randomized control trial	Intervention	Intervention	PTS at 24 Months (measured by Villalta score > 5 or venous ulceration)	47%	P = 0.56	RR (95% CI) = 0.96 (0.82–1.11)	The addition of pharmaco-mechanical catheter directed thrombolysis to anticoagulation did not significantly lower the risk for PTS but did result in fewer cases of moderate-to-severe PTS at 24 months and significantly less severe PTS between 6 and 24 months follow-up. Pharmaco-mechanical catheter directed thrombolysis and anticoagulation resulted in a significantly higher risk for major bleeding within 10 days compared with anticoagulation alone.
		Control	Control		48%			

(Continued)

Reference	Type of study	Intervention and control	Number of patients	Outcome			Result (efficacy and safety)	
Comerota et al. ¹⁵	Randomized control trial	Intervention	Intervention	140	PTS at 24 Months (measured by Villalta score > 5 or venous ulceration)		There was no significant difference in the occurrence of PTS at 24 months between the anticoagulation and pharmaco-mechanical thrombolysis group and anticoagulation alone group but the severity of PTS at 24 months was significantly lower in those treated with pharmaco-mechanical thrombolysis and anticoagulation compared with anticoagulation alone.	
					49%	P = 0.59		RR (95% CI) 0.95 (0.78–1.15)
					51%			
		Control	Control	160				
Sharifi et al. ¹⁷	Randomized control trial	Intervention	Intervention	88	PTS at 6 months ^a			PEVI with anticoagulation was associated with significantly less development of PTS at 6 months compared with anticoagulation alone and significantly less severe PTS at 6 months.
					3.4%	P < 0.001	No other statistics were reported.	
					27.2%			
		Control	Control	81				

PTS, post thrombotic syndrome; DVT, deep vein thrombosis; CDTL, catheter-directed thrombolysis; CI, confidence interval; RR, risk ratio; low-molecular weight heparin.

^aPTS defined as the presence of at least two new symptoms of: leg burning, pain, aches, discomfort, restlessness, and tingling plus the following signs: edema plus venous reflux, skin hyperpigmentation, or lipodermatosclerosis, and healed or active ulcer.

Table 2. Endovenous Stenting Following CDTL for the Maintenance of Venous Patency

Reference	Type of study	Intervention	Number of patients	Result
Park et al. ¹⁹	Retrospective case series	Iliac vein stenting after catheter-directed thrombolysis.	51	Primary patency rate was 95.8%, 87.5%, and 84.3% at 6, 12, and 24 months, respectively. 7.8% had recurrent thrombotic occlusion during follow-up (mean follow-up was 15.6 months). 3.9% of patients experienced complications from the stenting procedure.
Srinivas et al. ²⁰	Prospective case series	Venous stenting following CDTL in patients with proximal lower limb DVT in patients with residual venous obstruction or large clot burden.	8	Zero patients (0%) experienced a recurrence of VTE. One patient (12.5%) developed PTS and only one patient experienced stent occlusion during the 12 months follow-up.
Liu et al. ²¹	Retrospective cohort study	Direct stenting after angioplasty thrombectomy. Staged stenting after angioplasty thrombectomy plus catheter-directed thrombolysis with urokinase.	Direct stenting after thrombectomy = 46 Staged stenting after thrombectomy plus catheter-directed thrombolysis = 45	Direct stenting was associated with significantly less success in thrombolysis and a higher risk of developing PTS at 1 year. There were no significant differences in complication rates or primary patency rates at 1 year. Major bleeding occurred in no patients in either direct or staged stenting and minor bleeding occurred only in one patient who underwent staged stenting.
Funatsu A et al. ⁹	Retrospective case series	Venous stents for left iliac vein stenosis (of any degree) with acute DVT.	59	8% of patients experienced recurrent DVT. 8% of patients experienced PTS during follow-up (mean follow-up of 40 months). 7% of patients experienced stent occlusion in the acute phase (during hospitalization), whereas 9% of patients experienced stent occlusion in the chronic phase (after discharge). Primary patency was 84% at 19 months and secondary patency was 93% at 20 months.

Management of Iliofemoral DVT

It is important to note that endovascular management of DVT is often nonemergent. In the absence of an indication for urgent/emergent thrombolysis (i.e., phlegmasia cerulea dolens, venous infarct, or limb ischemia), patients with large clot burden, low bleeding risk, and additional risk factors for PTS may be considered for thrombolysis within 14 days of symptom onset.¹⁸ However, endovascular management is best performed in the acute phase before the chronic transformation of the blood clot occurs, and there is subsequent vein and venous valve damage.⁵ The mean time to randomization in the previous studies was approximately 6–7 days.^{3,13,14} Acknowledging that thrombolysis is likely more effective the more proximate to thrombosis onset, the current Canadian guideline from 2015 recommends that clinicians should treat initially with therapeutic anticoagulation (UFH or low-molecular weight heparin), early mobilization, and rapid follow-up, reassessing the need for an endovascular approach following immediate response to anticoagulation.^{1,5} Heparin is the preferred initial anticoagulation therapy in patients with iliofemoral DVT who do not receive endovenous management as it can be more easily adjusted or reversed if the need for thrombolysis arises.¹

The optimal long-term antithrombotic therapy following endovascular treatment of DVT and stenting remains controversial. In general, the duration of anticoagulation should be based on patient-specific risk for recurrent thrombosis (informed by provoking factors preceding thrombosis) and bleeding.²² In patients with venous stents, the need for concurrent anticoagulant and antiplatelet therapy is unclear. Similarly, the duration of anticoagulation or antiplatelet therapy is not well established. A 2019 systematic review of antithrombotic therapies in MTS patients following venous stents identified only five small retrospective studies with no consistency in antithrombotic choice or duration.²³ A subsequent larger retrospective study showed similar variability following venous stenting in the MTS, PTS, and acute DVT populations.²⁴ This equipoise is reflected by the huge variation in practice regarding antithrombotic choices.²⁵ While there has been a recent proliferation of evidence regarding optimal anticoagulant/antiplatelet combinations in patients with percutaneous coronary interventions and an indication for anticoagulation, this evidence cannot be directly applied to endovenous procedures because of differences in the mechanical properties of the stents, the structural constitution, flow patterns within the vessels, and the rate and ramifications of in-stent thrombosis.^{26–29}

Conclusion

The mainstay of treatment for DVT remains therapeutic anticoagulation and early mobilization. While there remains

conflicting data on the use of CDTL and PMT, endovascular approaches may be considered using a risk-benefit analysis on a case-by-case basis for patients with iliofemoral DVT, low bleeding risk, and other risk factors for the development of severe PTS. Patients with MTS have an anatomical variation that both predisposes to iliofemoral DVT and may plausibly benefit from intervention. We present a case of a 38-year-old female with MTS who underwent CDTL and stenting with an excellent result despite a large thrombotic burden. While CDTL and stenting should not be utilized routinely in the treatment of DVT, they can be judiciously considered in select circumstances, such as MTS, to obtain and maintain venous patency. Further investigations are required to evaluate the efficacy of the percutaneous intervention in the MTS population and to determine optimal antithrombotic therapy following stenting.

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