Vena cava filter deployment prior to percutaneous endovenous therapy for proximal lower limb deep venous thrombosis: should we routinely practice?

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Context
Anticoagulant therapy remains the prevalent treatment for venous thromboembolism. In the new era of percutaneous endovenous intervention, there is a progressive rise in the use of percutaneous endoluminal clot dissolution techniques such as using catheter-directed thrombolysis (CDT) and mechanical aspiration thrombectomy (MAT) devices due to their established short-term benefits. Prophylactic deployment of inferior vena cava (IVC) filter during percutaneous endovenous therapy for lower extremity deep venous thrombosis (DVT) is still a debatable issue.

Aims
Our study aims to assess retrospectively the frequency of embolization and the need for deployment of a retrievable IVC filter during endovenous treatment of proximal lower extremity DVT using percutaneous CDT and MAT techniques.

Settings and design
Retrospective.

Patients and methods
Percutaneous endoluminal clot dissolution using either CDT or MAT for proximal lower extremity DVT was performed on 64 limbs in 58 patients of 148 patients diagnosed with proximal acute/subacute DVT in the Vascular Surgery Department of the study hospitals. An IVC filter was deployed in 32 patients prior or during the procedure.

Statistical analysis
Statistical analysis was performed by using IBM SPSS Statistics, version 22, for Windows program package (SPSS Inc., Chicago, Illinois, USA).

Results
From 58 patients who were treated for proximal DVT with clot debulking procedures, the IVC filter was prophylactically deployed in 30 (51.7%) patients. Trapped thrombus in the deployed filters as revealed on venocavography was observed in 8/30 (26.7%) filters deployed prophylactically with an overall rate of thrombus embolization during percutaneous endovenous thrombus dissolution techniques was 11/58 (18.9%) patients.

Conclusion
CDT could be done safely and effectively without routine prophylactic IVC filter placement in treating acute DVT. Selective filter placement may be considered in patients undergoing mechanical thrombectomy or patients with more proximal thrombus pattern with multiple risk factors.

Keywords:
filter, thrombolysis, vena cava, venous thromboembolism

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Introduction

Venous thromboembolism (VTE) that includes deep venous thrombosis (DVT) and pulmonary embolism (PE) is rated as the third leading vascular disease after myocardial infarction and stroke [1]. PE and phlegmasia cerulea dolens are the most alarming serious complications of extensive lower extremity DVT, while recurrent VTE and post-thrombotic syndrome are the most lasting chronic, debilitating complications [2]. The efficient treatment of VTE remains a clinical challenge due to related morbidity and mortality. Intravenous anticoagulation with unfractionated heparin or subcutaneous low-molecular weight heparin overlapping with oral vitamin K antagonists has been the mainstay of therapy for DVT. Their main value is to prevent propagation of thrombus and reduce life-threatening PE; however, anticoagulant therapy may fail to reduce or even eliminate the actual clot that is resolved by the patient's own system. Recurrence of VTE is reported to be up to 25%; this may increase to more than 50% in patients who do not undergo anticoagulant therapy for an extended period [3]. Percutaneous endovenous thrombo-ablative modalities are aiming to reduce clot burden or complete clearance of the clot are considered advantageous to keep valvular function and reduce the risk of chronic venous insufficiency [4]. Adjunctive procedures may be utilized during percutaneous endovenous thrombolysis to ameliorate outcome and reduce complications. Prophylactic inferior vena cava (IVC) filters are deployed to reduce thrombolysis-associated PE. Although frequently performed, this practice is debatable due to that fact that there is no evidence to support its routine use. Specifically, no increase in PE was identified in patients who underwent standard catheter-directed thrombolysis (CDT) without filter deployment [5]. It is hypothesized that mechanical stress applied to the clot by the catheter-based clot dissolution procedures and the accelerated lytic process might increase the number and size of showering emboli resulting in symptomatic or silent PE [6]. A theoretical risk of thrombus lysis is iatrogenic-induced PE and wisdom would suggest that in a patient at high risk of PE an IVC filter should be deployed prethrombolysis. However, the rate of PE after pharmacological or mechanical thrombolysis remains low [7].

Patients and methods

Study design and patient selection

Our study was a retrospective study performed at the Vascular Surgery Department of two tertiary hospitals in Egypt (Benha University Hospitals, Ain Shams University Hospitals) and one tertiary hospital in Saudi Arabia (Security Forces Hospital - Makkah) after the review board in the enrolled hospitals approved the study protocol. Our database was revised to identify and analyze all patients with proximal DVT who were treated between March 2016 and February 2018. From 148 patients who were diagnosed with proximal acute and subacute lower extremity DVT, 58 patients accepted to undergo interventional debulking therapy. According to our treatment policy patients with proximal DVT who presented within 3 weeks from the onset of symptoms and had no contraindication to anticoagulants and local lytic therapy were treated with CDT. Patients who had a high risk for bleeding with lytic therapy were offered mechanical aspiration thrombectomy (MAT) as an alternative option; patients' demographics are summarized in Table 1. Informed consent was obtained from all patients after the risks and benefits of the treatment were fully explained.

Table 1 Demographic data, clinical presentation, and risk factors

Study groups	*n* (%)
Sex	
Male	20 (34.5)
Female	38 (65.5)
Age (years)	
Range	24–56
Mean±SD	34.5±7.16
Symptom duration (days) (CDT)	4–20
	45.96 ±11.0
Clinical presentation	
Edema	26 (44.8)
Pain and edema	21 (36.2)
Pain	6 (10.3)
Phlegmasia cerulea dolens	5 (8.6)
Associated pulmonary embolism	2 (3.4)
Patients with bilateral lower limb DVT	6 (10.3)
Thrombus location	
Iliac	15 (25.9)
Without extension to IVC	10 (17.2)
With extension to IVC	5 (8.6)
Iliofemoral	32 (55.2)
Without extension to IVC	28 (48.3)
With extension to IVC	4 (6.9)
Femoral-popliteal	11 (18.9)
Without extension to calf veins	8 (13.8)
With extension to calf veins	3 (5.1)
Risk factors	
Patients with risk factors	45 (77.6)
Strong risk factors	5 (8.6)
Moderate risk factors	26 (44.8)
Weak risk factors	6 (10.3)
Combined risk factors	8 (13.8)
Patients with absent risk factors	13 (22.4)
Risk factors classification	
Strong risk factors	
Major surgery	8/45 (17.8)
Moderate risk factors	
Oral contraceptive pills	10/45 (22.2)
Thrombophilia	8/45 (17.8)
Pregnancy	4/45 (8.9)
Postcesarean section	12/45 (26.7)
Malignancy	5/45 (11.1)
Previous DVT	9/45 (20)
Family history	5/45 (11.1)
Weak risk factors	
Immobilization	8/45 (17.8)
Patients with permissive lesion (iliac vein compression)	18 (31)

CDT, catheter-directed thrombolysis; DVT, deep venous thrombosis; IVC, inferior vena cava.

Diagnostic workup

The Society of Interventional Radiology guidelines have defined proximal DVT as the complete or partial thrombosis of the popliteal vein, femoral vein, common femoral vein, iliac vein, and/or IVC [8]. All patients in our study were diagnosed for proximal DVT by color Doppler ultrasonography (CDU). The patients who accepted to undergo debulking therapy were investigated for the documentation of proximal lung embolization by computed tomography pulmonary angiogram before and after the debulking therapy.

Patient selection

Patients with acute/subacute extensive proximal lower extremity DVT with symptoms duration of up to 3 weeks were selected. Patients with thrombus located in the iliac vein with/without IVC extension, iliofemoral vein with/without IVC extension, femoropopliteal segment that included common femoral vein with/without calf vein extension were included. Patients who had no contraindication for local lytic therapy were offered CDT, while patients with relative contraindications like previous major surgery and pregnancy or when rapid restoration of venous flow is crucial were treated with MAT.

Risk factor evaluation

The distinct risk factors for DVT included postoperative state, prior history of DVT, pregnancy and postpartum state, malignancy, hormonal therapy like oral contraceptive pills, and inherited coagulation disorders. Our patients were screened for underlying thrombophilia including protein C deficiency, protein S deficiency, antithrombin deficiency, activated protein C resistance (Factor V Leiden), cardiolipin antibodies, lupus anticoagulant, and prothrombin gene mutation. Permissive lesions such as iliac vein outflow obstruction were assessed after debulking therapy by conventional venacavogram in two different projections (Table 1).

Endovascular treatment techniques

Our access approach was duplex-guided ipsilateral antegrade popliteal vein in prone position, other optional puncture site was the ipsilateral posterior tibial vein (Table 2), and this was depending on the involvement of the calf muscle veins and the used debulking modality. A bolus of 5000 U of heparin sodium was immediately administered through the sheath after confirming the diagnosis of acute proximal DVT. In patients operated on for CDT, the decision for prophylactic IVC retrievable filter deployment was operator specific according to patients' risk factors and the thrombus pattern (Table 1); it was deployed before starting local debulking therapy in 19 patients. Two patients received IVC filter during the procedure due to symptomatic proximal lung embolization, all filters were deployed through the contralateral femoral access or right jagular access; filters deployed in our patients were Denali retrievable vena cava filter (Bard Peripheral Vascular, Tempe, Arizona, USA) and Celect Platinum IVC filter (Cook Medical, Bloomington, Indiana, USA). After evaluation of venous anatomy and complete extension of the thrombus through venography, an appropriate-length Fountain infusion catheter 135 cm with infusion segment 30–50 cm was inserted (Merit Medical System Inc., South Jordan, Utah, USA). Catheter-directed infusion of alteplase (Actilyse; Boehringer-Ingelheim, Ingelheim am Rhein, Germany) was then established at an infusion rate of

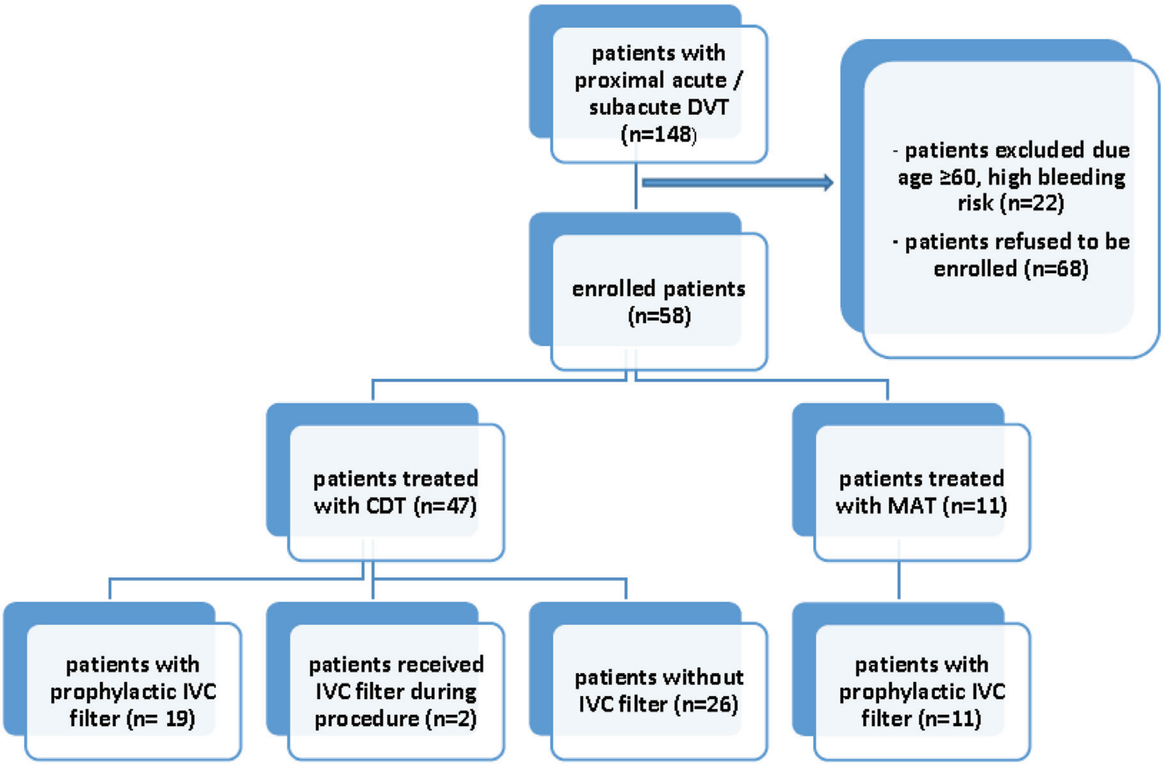
Table 2 Procedure details

Procedure details	*n* (%)
Procedure	
CDT	47 (81)
MAT	11 (19)
Access	
Single access	26 (44.8)
Popliteal access	23 (88.6)
Posterior tibial access	3 (11.5)
Dual access	32 (55.2)
Main procedure access (popliteal access)	32 (55.2)
Filter deployment access	
Transjugular access	17 (53.1)
Contralateral common femoral vein access	15 (46.9)
Filter deployment	32 (55.2)
Prophylactic	30 (51.7)
During procedure	2 (3.4)
Retrieved filters	15/32 (46.8)
Nonretrieved filters	17/32 (53.1)
Failed retrieval	7/32 (19.4)
Patients lost during follow-up	10/32 (32.2)
Procedure duration	
CDT	
24 h duration	7 (12.1)
48 h duration	37 (63.8)
72 h duration	3 (5.1)
MAT	
Single-session therapy (average 3 h)	6 (10.3)
Single-session with 12 h extended lytic therapy	5 (8.6)
Iliac vein stenting	23/58 (39.6)
Due to iliac vein outflow obstruction	18 (31)
Due to residual iliac thrombus	5 (8.6)
Complications	9/58 (15.5)
Procedure-related PE	3 (5.1)
Symptomatic	2 (3.4)
Asymptomatic	1 (1.7)
Puncture site bleeding	6 (10.3)

CDT, catheter-directed thrombolysis; MAT, mechanical aspiration thrombectomy; PE, pulmonary embolism.

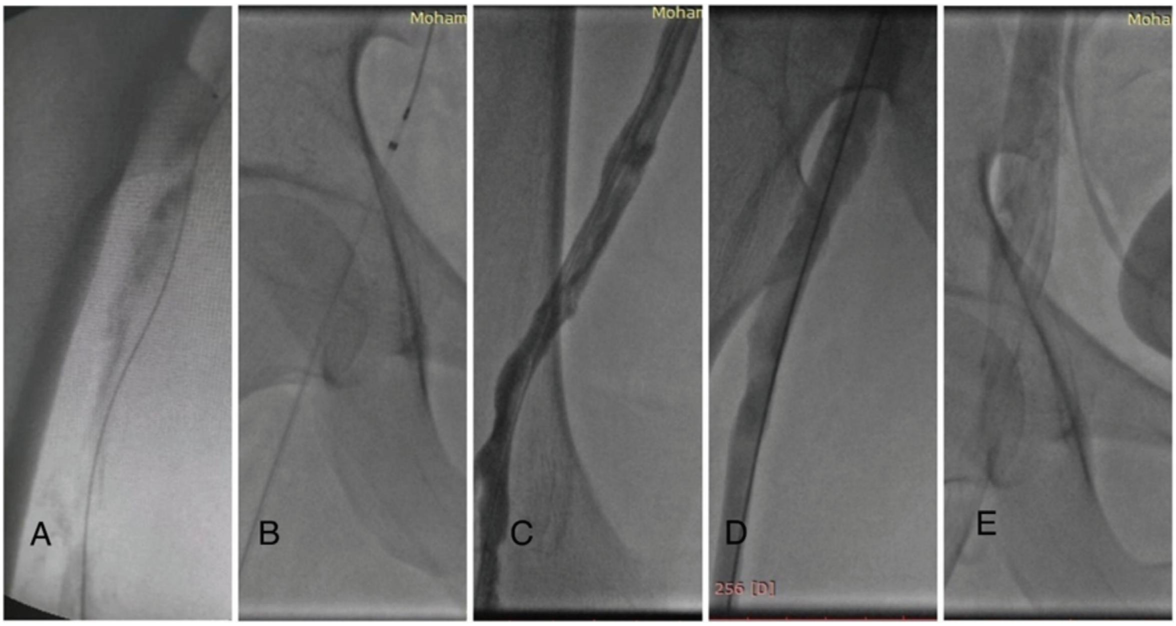
1–2 mg/h according to thrombus load (Figs 1–3). We maximized thrombus penetration by 10 rapid and forceful manual pulse injections of 1-ml with the Squirt fluid dispensing system (Merit Medical System Inc.) every 60 s. All patients received concomitant heparin injection every 4 h through the side port of the access sheath during the procedure. Ascending venography was performed every 2 days,

Figure 1



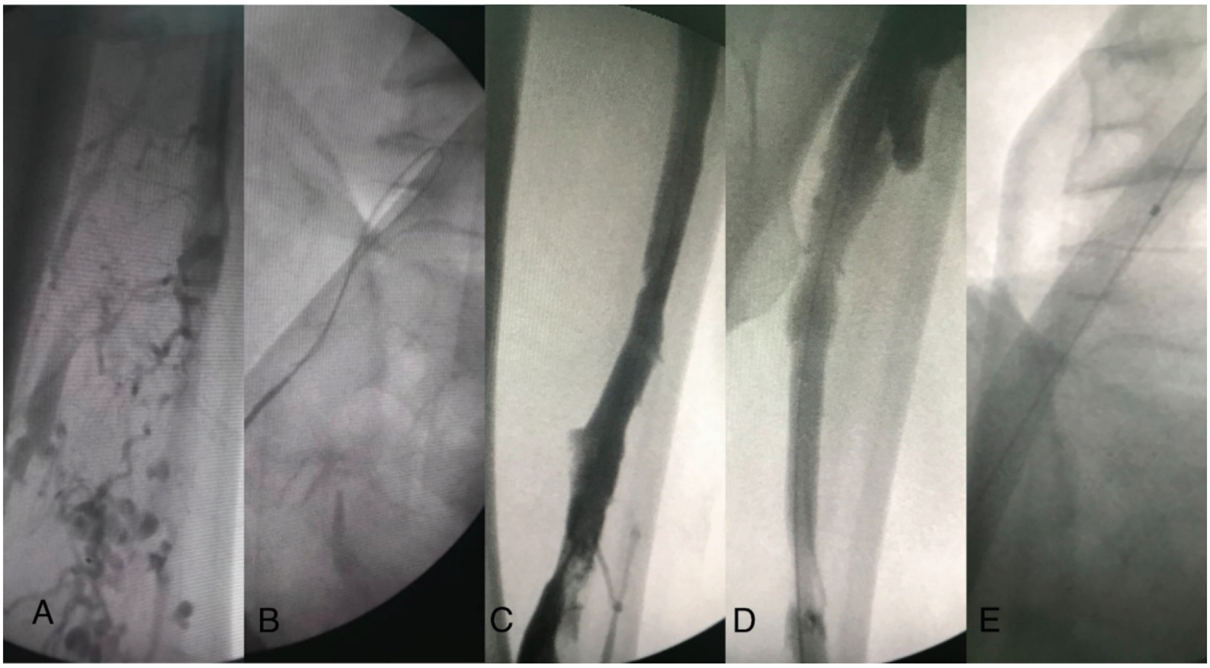
Patient consort and flow chart of the study design.

Figure 2



A 28-year-old male with left femoropopliteal DVT (prone position) (a) irregular filling defect of the femoral vein, (b) extension of fountain catheter to iliac vein beyond the level of thrombus, (c–e) uninterrupted flow through recanalized femoral and iliac vein 48 h after pulse-spray CDT. CDT, catheter-directed thrombolysis; DVT, deep venous thrombosis.

Figure 3



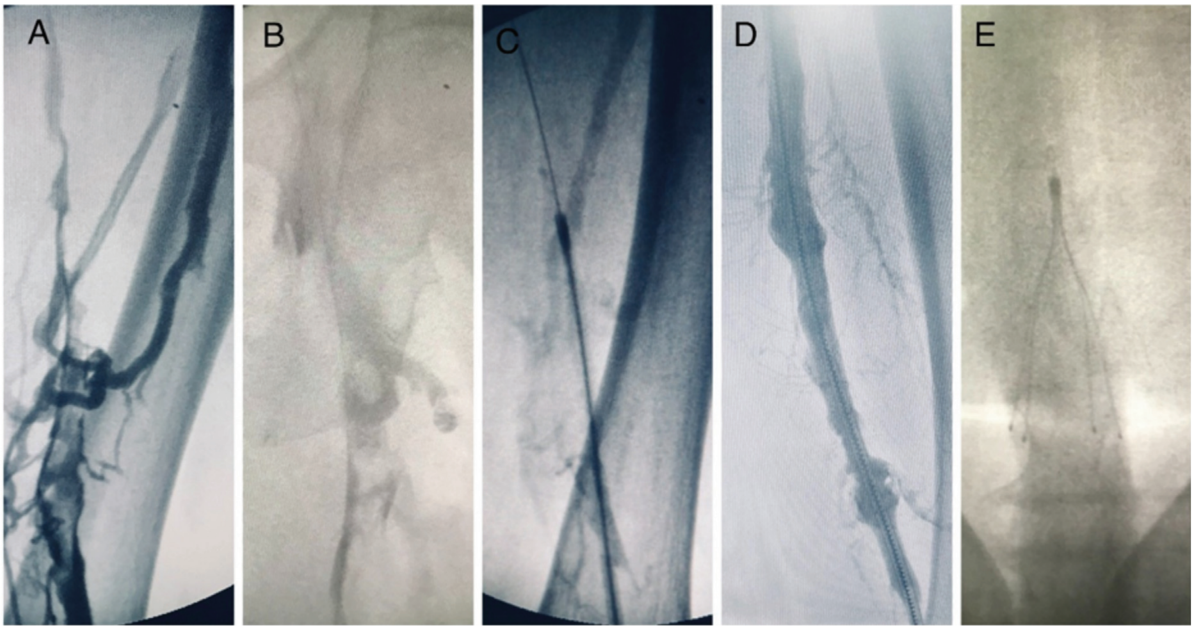
A 48-year-old man with left iliofemoral DVT (prone position): (a) irregular filling defect of the femoral vein, (b) Terumo wire made a loop through iliac lesion, (c–e) uninterrupted flow through the recanalized femoral vein and stented iliac vein 48 h after pulse-spray pharmacological CDT. CDT, catheter-directed thrombolysis; DVT, deep venous thrombosis.

while thrombus resolution was assessed every 24 h by CDU to assess the degree of recanalization. Complete recanalization documented by CDU hemodynamics was the indication to stop lysis procedure and perform the final venogram. If the angiographic results were unsatisfactory (<50% of clot lysis), thrombolytic therapy was extended for no longer than 72 h, to avoid bleeding complications. In 11 patients operated upon for MAT prophylactic IVC filter was routinely deployed before starting the technique. Through a 10 Fr sheath over a 0.018-inch guidewire the aspiration catheter was introduced. The 8 Fr Aspirex catheter (Straub, Wangs, Switzerland) comprises a nonrotating head (with an L-shaped tip) and a high-speed rotational coil within the body. The distal end of the catheter was placed at the site of the thrombus and the catheter was spun quickly to macerate the thrombus and remove it by aspiration with powerful suction (Figs 4 and 5). It was passed several times all through the thrombosed segment from distal to proximal till recanalization is accomplished. After thrombus ablation was complete, the suspected underlying chronic obstructions and residual thromboses were stented after assessment in two different projections and after a balloon inflation test. Filter thrombus load was assessed by the completion venacavogram. Contrast-filling defects within the filter were interpreted as emboli. Filter thrombus load (Fig. 6a, b) was classified based on the thrombus size relative to the length of the filter struts. Anticoagulation with unfractionated or low-molecular heparin was resumed as soon as possible after sheath removal, usually within 2 h. For long-term therapy, oral anticoagulation with warfarin or other novel oral anticoagulants [direct factor Xa inhibitors (apixaban, rivaroxaban)] was prescribed based on the guidelines of DVT therapy. Filter retrieval was performed in some patients who had no evidence filter thrombus or after filter thrombus lysis by 12 h extended lytic therapy at another session before hospital discharge. Other patients were arranged for filter retrieval during the follow-up period (Fig. 7).

Evaluation of filter thrombus and proximal embolization

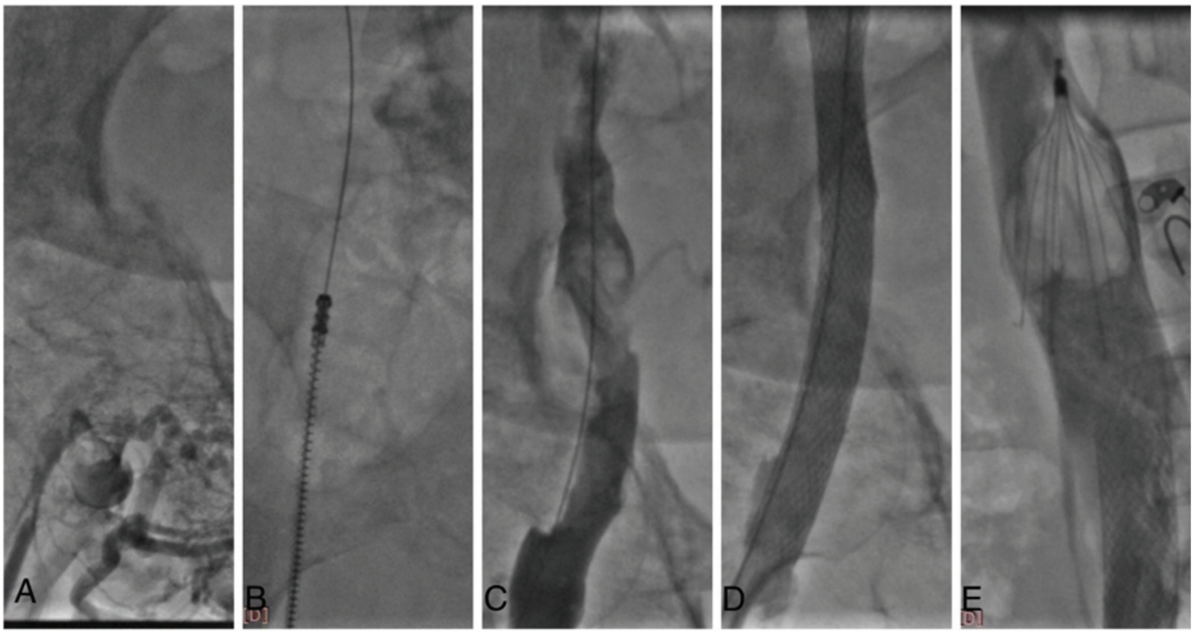
We revised retrospectively all preoperative pulmonary CTA reports of the target patients, their venacavograms done after placement of the infusion catheter system and IVC filter, the completion venacavograms stored on hardcopies (2016–2018) and postoperative pulmonary CTA. Contrast-filling defects within the filter were interpreted as emboli (Fig. 6). The thrombus load was classified according to visible emboli size in relation to the length of the filter struts. Filter thrombus load grade 0: no thrombus seen on venogram, grade 1: trapped thrombus filled less than one-fourth the height of the filter, grade 2: trapped thrombus filled more than or equal to one-fourth to less than half the height of the filter, grade 3: trapped thrombus filled more than or equal to half but

Figure 4



A 39-year old women with right femoral DVT (prone position): (a, b) femoral vein thrombosis with prominent collaterals, (c) MAT by Aspirex 8 Fr catheter, (d) uninterrupted flow through the femoral vein, (e) cavogram shows grade 0 filter thrombus load. DVT, deep venous thrombosis; MAT, mechanical aspiration thrombectomy.

Figure 5



A 35-year old woman with right lower limb phlegmasia cerulea dolens (supine position): (a) common femoral and iliac vein thrombosis with prominent groin collaterals, (b) MAT with Aspirex 8F catheter, (c) residual iliac vein thrombus, (d) poststenting venogram with adequate flow, and (e) cavogram with grade 3 trapped filter thrombus. MAT, mechanical aspiration thrombectomy.

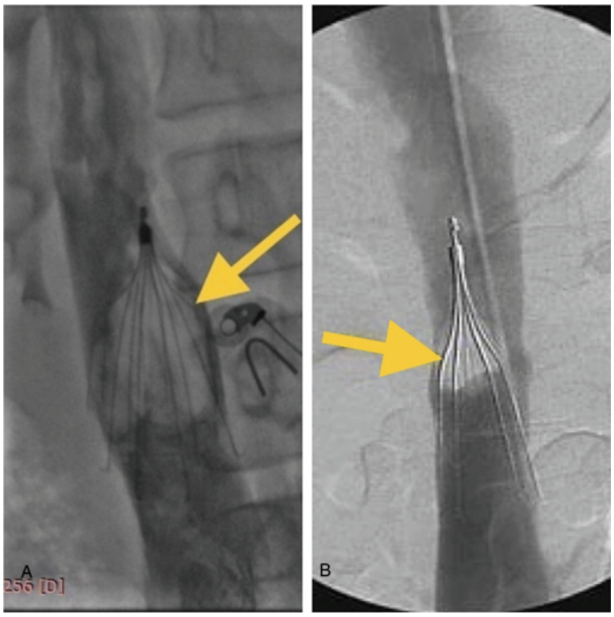
within the height of the filter, grade 4: trapped thrombus filled greater than the height of the filter.

Results

Our retrospective analysis of 58 patients who underwent percutaneous endovenous thromboablation for extensive lower extremity DVT utilizing CDT and MAT with/without prophylactic vena cava filtration shows 38 (65.5%) patients were women and 20 (34.5%) were men with mean age (mean±SD, 34.5 ±7.16). Unilateral lower extremity DVT was in seen 52 (89.7%) patients and bilateral lower extremity DVT in six (10.3%) patients in the form of edema was in 26

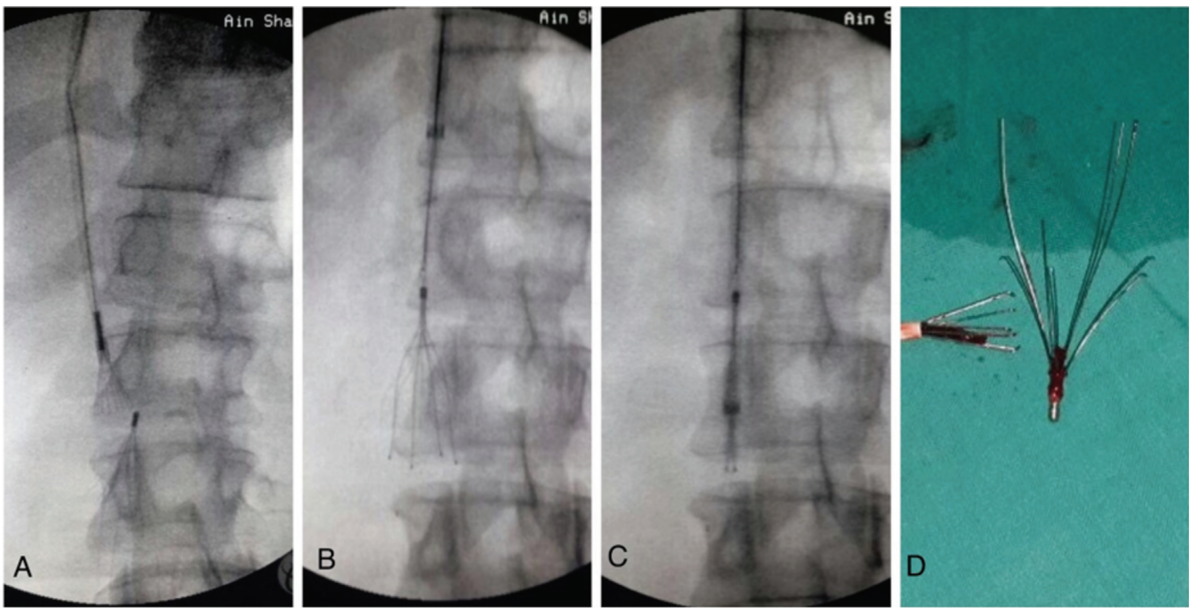
(44.8%) patients, pain and edema in 21 (36.2%) patients, pain in six (10.3%) patients, and phlegmasia cerulea dolens in five (8.6%) patients. Two of the studied patients had showering PE (3.4%) before the initiation of endovenous therapy. Thrombus was located in iliac vein in 15 (25.9%) patients, iliofemoral venous segment in 32 (55.2%) patients, IVC was involved in nine (15.5%) patients, and femoropopliteal venous segment was included in 11 (18.9%) patients. Forty-five (77.6%) patients had risk factors for DVT as summarized in Table 1. Of enrolled patients, 18 (31%) were found after completion venogram to have iliac vein outflow obstructive lesion; 47 (81%) patients were operated upon for CDT while 11 (19%) patients were operated upon for MAT. In our study, 32 retrievable IVC filter were successfully deployed in 32 (55.1%) patients, preprocedure prophylactic deployment was in 30 (51.7%), 19 (63.3%) filters in CDT patients, and 11 (36.6%) filters in MAT patients, while two (3.4%) patients received IVC filter during the procedure due to symptomatic PE. In CDT patients, the mean duration of thrombolytic therapy was 45.96±11.0 h, complete recanalization was achieved in seven (12.1%) patients with isolated iliac vein thrombosis after 24 h of thrombolysis, 37 (63.8%) patients after 48 h of thrombolysis, and three (5.2%) patients with bilateral lower extremity DVT required extended therapy for 72 h due to extensive residual thrombus and to allow IVC filter thrombus lysis after repositioning of the catheter. In MAT patients, in six (10.3%) patients complete recanalization was achieved with a single-session therapy and five (8.6%) required additional thrombolytic drug infusion for 12 h. Technical success with restoration of venous flow on the final venogram was achieved in all 58 patients. Adjunctive iliac vein stenting was done in 23 (39.6%) patients, 18 (31%) patients due to iliac vein outflow obstructive lesion and five (8.6%) patients due to residual iliac vein thrombus. Complications happened

Figure 6



Venacavogram of filter trapped thrombus: (a) grade 3, the trapped thrombus filled more than or equal to half but within the height of the filter, (b) grade 2, the trapped thrombus filled more than or equal to one-fourth to less than half the height of the filter.

Figure 7



Filter retrieval procedure: (a–c) snaring and sheathing of filter, (d) retrieved filter with no retained thrombus along its struts.

in nine (15.5%) patients; three (5.1%) patients had procedure-related PE, two (3.4%) patients were symptomatic that was managed by filter deployment and one (1.7%) was silent and detected by postprocedure computed tomography pulmonary angiogram. Six (10.3%) patients had access site hematoma, two of them related to during procedure filter deployment. Proximal embolization was recognized in 11 (18.9%) patients during revision of venacavograms and postprocedure pulmonary CTA. Eight (72.7%) patients underwent preoperative IVC filter placement, while the other three (27.3%) were without the IVC filter; two patients had symptomatic PE during the procedure necessitating filter placement and one patient was asymptomatic. Filter thrombus load was graded from 0 to 4, three (37.5%) of the eight patients with embolization had grade 1, four (50%) patients had grade 2, and one (12.5%) had grade 4 filter thrombus load. Proximal embolization to IVC filter or to lung was analyzed in relation to patients' characteristics and procedure details. They are summarized in Tables 3 and 4. We found proximal embolization was more frequent in proximal lesions with caval extension. No proximal embolization happened in patients with absent risk factors (P=0.026). Malignancy as a risk factor was associated with increased proximal embolization (P=0.04). Proximal embolization was less frequent in patients who underwent iliac vein stenting due to iliac vein outflow obstruction; however, it was not statistically significant. Subanalysis of patients showed no significant differences in other patient-related and procedure-related factors, such as age, sex, use of thrombolytic catheter or mechanical thrombectomy

Table 3 Patient characteristics and proximal embolization

	Proximal embolization [*n* (%)]		FET	*P* value
	Yes (11)	No (47)		
Sex				
Male	4 (36.4)	16 (34.0)	0.0	1.0
Female	7 (63.6)	31 (66.0)		
Age (year)				
Mean±SD	37.82±10.99	33.72±5.83	St *t*=1.74	0.09
Range	24–50	24–56		
Clinical presentation				
Edema	6 (54.5)	20 (42.6)	1.46	0.80
Pain and edema	4 (36.4)	17 (36.2)		
Pain	0 (0.0)	6 (12.8)		
Phlegmasia cerulean dolens	1 (9.1)	4 (8.5)		
Level of DVT				
Iliac	3 (27.3)	7 (14.9)	7.14	0.041*
Iliocaval	4 (36.4)	5 (10.6)		
Iliofemoral with caval extension	4 (36.4)	24 (51.1)		
Femoral-popliteal	0 (0.0)	11 (23.4)		
Risk factors				
Patients with absent risk factors	0 (0.0)	13 (27.7)	9.4	0.026*
Strong risk factors	0 (0.0)	5 (10.6)		
Moderate risk factors	6 (54.5)	21 (44.7)		
Weak risk factors	1 (9.1)	5 (10.6)		
Combined risk factors	4 (36.4)	3 (6.4)		
Risk factor classification				
Strong risk factors (major surgery)	3 (27.3)	7 (14.9)	0.29	0.38
Moderate risk factors				
Oral contraceptive pills	2 (18.2)	8 (17.0)	0.0	1.0
Thrombophilia	2 (18.2)	6 (12.8)	0.0	0.64
Pregnancy	1 (9.1)	1 (2.1)	0.05	0.35
Postcesarean section	1 (9.1)	10 (21.3)	0.25	0.67
Malignancy	3 (27.3)	2 (4.3)	3.43	0.04*
Previous DVT	4 (36.4)	9 (19.1)	0.69	0.24
Family history	0 (0.0)	3 (6.4)	0.01	1.0
Weak risk factors (immobilization)	3 (27.3)	5 (10.6)	0.91	0.17
Patients with permissive lesion (iliac vein compression)	3 (27.3)	15 (31.9)	0.0	1.0

DVT, deep venous thrombosis; FET, Fisher's exact test. P value $P<0.05$.

Table 4 Procedure details in relation to proximal embolization

Procedure details	Proximal embolization [*n* (%)]		FET	*P* value
	Yes (11)	No (47)		
Procedure				
CDT	7 (63.6)	40 (85.1)	1.46	0.19
MAT	4 (36.4)	7 (14.9)		
Preprocedure CTPA evidence of pulmonary embolism	2 (18.2)	0 (0.0)	4.23	0.033*
Postprocedure CTPA evidence of proximal lung showering	3 (27.3)	0 (0.0)	8.53	0.005**
Filter deployment				
Prophylactic	8 (72.7)	22 (46.8)	0.93	0.31
During procedure	2 (18.2)	0 (0.0)	0.64	0.19
Filter deployment				
Yes	8 (72.7)	24 (51.1)	2.3	0.09
No	3 (27.3)	23 (48.9)		
Procedure duration				
CDT				
24 h duration	1 (9.1)	6 (12.8)		
48 h duration	5 (45.5)	32 (68.1)	4.36	0.30
72 h duration	1 (9.1)	2 (4.3)		
MAT				
Single-session therapy (average 3 h)	3 (27.3)	5 (10.6)		
Single-session with 12 h extended lytic therapy	1 (9.1)	2 (4.3)		
Iliac vein stenting				
Due to iliac vein compression	3 (27.3)	15 (31.9)	0.0	1.0

CDT, catheter-directed thrombolysis; CTPA, computed tomography pulmonary angiogram; FET, Fisher's exact test; MAT, mechanical aspiration thrombectomy. P<0. 001.

devices, or thrombolysis time. There was no PE breakthrough (defined as new PE occurring after IVC filter placement) was seen in any of the patients; 15 (46.8%) filters were retrieved successfully, while seven (19.4%) filters failed to be retrieved due to erosion of the IVC wall, filter tilting and identified thrombus within the filter.

Discussion

One of the main concerns and premonitions related to the use of MAT and to a lesser extent with CDT in patients with extensive DVTs is development of PE during percutaneous therapy. The use of IVC filters as an adjunct procedure to CDT/MAT remains controversial and not well established as data from controlled studies are lacking [9]. However, there has been little debate on the necessity of filter deployment during therapies for DVT using percutaneous endovascular procedures other than CDT [10]. How many times we have heard from many people what they said about they never placed IVC filter during thrombolysis, while others insisted on routine use before every case. With this conflict in opinions and practice, our study findings show that among the 58 treated patients, the overall incidence of proximal embolization was 18.9%. Patients with retrievable filter deployment were 55.2% of patients; 26.7% of patients with IVC filter showed evidence of proximal showering with variable grades of filter thrombus load and 10.7% of patients without IVC filter developed proximal embolization during CDT and MAT in the form of symptomatic PE (7.1%) and a symptomatic PE (3.6%). Kölbel *et al.* [11] demonstrated that nearly 45% of retrievable IVC filters placed prior to CDT±PMCT for proximal DVT showed a visible thrombus in the filter while Jiang *et al.* [12] reported the incidence of IVC filter thrombus of patients with acute proximal DVT during CDT was 4.2% which was much lower than that of the Kölbel *et al.* study. Our results were higher than Jiang and colleagues which may be due to the large patient sample included in their study. However, our results and Jiang and colleagues results were much lower than Kölbel and colleagues; this is could be explained by (a) Kölbel's series which included only iliocaval DVT, while the femoropopliteal vein, iliofemoral vein, and iliac/iliocaval vein DVTs were all included in our study; (b) the continuously pumping of thrombolytic drug through the catheter for 48 h and the ascending venography was performed every 2 days may underestimate the true incidence of filter embolization due to continuous lysis of the small size filter thrombus before being detected.

The filter implantation to lower thromboembolic risk in percutaneous endovascular intervention trial published by the Arizona Heart and Vascular

Institute randomized 141 patients undergoing PEVI for acute massive DVT to receive a prophylactic IVC filter (filter group, 70 patients) or to receive no filter (control group, 71 patients) showed an eightfold increase in symptomatic iatrogenic PE in those not receiving a filter. However, no increased mortality was noted in patients without a filter [13]. All PEs were in the groups undergoing pharmaco-mechanical techniques; no PE developed in patients undergoing CDT alone. The biggest single criticism of this trial is that no preoperative imaging of the pulmonary arteries was obtained. The analysis of our patient-related and procedure-related factors showed that the absence of risk factors for DVT was a predictor for safe procedure while the presence of risk factors was associated with proximal embolization. We expected a higher number of patients with embolization in MAT patients; however, 36.4% of patients who underwent MAT showed proximal showering to the routinely placed retrievable filter that was not statistically significantly different from CDT. Chung and colleagues reported selective IVC filters deployment in cases of thrombus extension to the IVC in the absence of venous stenosis of the common iliac vein on computed tomography scan. None of their patients who underwent aspiration thrombectomy with or without IVC filter placement experienced symptoms suggestive of PE [14]. From 18 patients recognized to have iliac vein outflow obstruction only three (16.7%) patients had proximal embolization in spite of the other 15 (83.3%) patients associated with the most proximal pattern of DVT and nine of them had more than one risk factors, so iliac vein obstructive lesions seem to be protective against proximal embolization. According to the results of this study three of the eight filters with thrombus load were lysed with CDT and 15 filters were successfully retrieved. The suitability for filter retrieval of the IVC filter containing thrombus is not well established. The manufacturers of the most type of filters recommend against retrieval if the thrombus is more than 25% of the volume of the filter [15,16]. Deferring filter removal may be inevitable because of an IVC filter thrombus patients missed during the follow-up period, which made filter retrieval more difficult. The routine placement of IVC filters is, therefore, not recommended. However, they should be considered in certain high-risk patients after assessment with an adequate protocol or patients with PE undergoing thrombus debulking therapy and should be of temporary type that allows rapid removal after restoration of the venous flow. This adds more expenses (especially with retrievable filters) to an already expensive procedure.

Limitation and recommendation

Our study was a retrospective study and our patient sample was small, coincidence may be considered as a reason of our findings. With most studies reporting the risk of PE with CDT to be very low, larger studies with very specific selection criteria are needed to make such recommendations. MAT techniques require more evaluating controlled studies to clarify the safety of this procedure with or without filter placement.

Conclusions

Placement of IVC filter prior to CDT is a controversial issue. However, it could be done safely and effectively without routine prophylactic IVC filter placement in treating acute DVT according to our results. Filter thrombus during CDT for the acute proximal DVT is uncommon. Selective filter placement may be considered in patients undergoing mechanical thrombectomy or patients with more proximal thrombus pattern with multiple risk factors. Iliac vein obstructive lesions appear to be protective against proximal embolization.

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Conflicts of interest

There are no conflicts of interest.

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