Original Article

Pharmaco-mechanical catheter-directed thrombolysis versus recanalization and stenting for post thrombotic syndrome after lower limb deep vein thrombosis: a comparative study

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Background: Endovenous interventional procedures can be used in addition to therapeutic anticoagulation to treat deep vein thrombosis in selected patients with proximal vein involvement (vena cava, iliac and/or common femoral). The aim of this study was to compare venous patency and the post-thrombotic syndrome (PTS) in patients treated with pharmaco-mechanical catheter-directed thrombolysis (PMT) versus recanalization-stenting for PTS after a proximal lower limb deep vein thrombosis.

Methods: Between January 2014 and December 2020, this retrospective and monocentric study included patients with very symptomatic acute iliofemoral deep vein thrombosis treated with PMT within 21 days after diagnosis (PMT group) and patients with PTS caused by chronic venous obstruction treated with recanalization and stenting (CRS group).

Results: A total of 116 patients were included (26 PMT, 90 CRS). The rate of primary patency was 81.8% (18/22 patients) in the PMT group and 78.4% (69/88) in the CRS group (P>0.99). The rate of venous patency at the last follow-up was 76.9% (20/26) in the PMT group and 82.2% (74/90) in the CRS group (P=0.57). The median number of stents was 2 (range, 0–5) in the PMT group and 3 (range, 0–7) in the CRS group (P<0.001). The median stent length was 150 mm (range, 60–390 mm) and 280 mm (range, 120–820 mm), respectively (P<0.001). The median last Villalta score was 2 (range, 0–10) in the PMT group and 2 (range, 0–21) in the CRS group (P=0.55). The rate of venous claudication at the last follow-up was 19.0% (4/21) in the PMT group and 12.0% (10/83) in the CRS group (P=0.47).

Conclusions: In this study, there was no difference in venous patency and in the rate and severity of PTS between the PMT and CRS groups. The number of stent and their length were significantly lower in the PMT group compared with the CRS group.

Keywords: Deep vein thrombosis (DVT); post-thrombotic syndrome (PTS); Villalta score; pharmaco-mechanical catheter-directed thrombolysis (PMT); venous angioplasty and stenting

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Introduction

Deep vein thrombosis (DVT) of the lower limb is a frequent disease with an annual incidence of 1–2 per 1,000 people (1,2). The treatment of DVT is therapeutic anticoagulation and its complications are pulmonary embolism (PE) or post-thrombotic syndrome (PTS). PTS can complicate 50% of proximal DVT and 5–10% had severe PTS (3-5). PTS is caused by fibrotic remodelling of the venous wall, leading to vessel caliber narrowing and/or valve destruction. Despite anticoagulation, PTS can have a major impact on quality of life (3-5) and the cost of its management is high (6). In addition, there is debate about preventive measures for PTS. Venous compression has been challenged by the SOX study (7). Indeed, this study showed similar results on the occurrence of PTS with or without elastic compression stockings after proximal DVT. Endovenous interventional procedures can be used in addition to therapeutic anticoagulation for selected patients with proximal vein involvement (vena cava, iliac and/or common femoral). In the acute phase, pharmaco-mechanical procedures can be considered to reduce the initial symptoms and the incidence of moderate or severe PTS in the medium term (8,9). In the chronic phase, recanalization by angioplasty and stenting can be discussed to treat symptomatic PTS (10-13).

The aim of this study was to compare venous patency and PTS after a proximal lower limb DVT treated either in the acute phase with Pharmaco-Mechanical catheter-directed Thrombolysis (PMT) or in the Chronic phase for venous obstruction with Recanalization and Stenting (CRS).

Methods

Study population

This retrospective study included consecutive patients from January 2014 until December 2020 in a university hospital. Comparisons were made between PMT group and CRS group consisting of patients with DVT of the lower limbs treated by endovenous procedure.

The PMT patients had a very symptomatic iliofemoral DVT associated with severe pain at rest or walking treated by PMT within 21 days after the diagnosis. The CRS patients had moderate or severe PTS according to the Villalta scale (Villalta score ≥10) or/and venous claudication with sequelae of the common femoral, iliac or inferior vena cava treated by recanalization-stenting.

The first phase of the endovenous procedure in PMT group was the delivery of plasminogen activator during 30 minutes, directly into lower limbs clot and the second phase was thrombectomy with the use of the Angiojet® (Boston Scientific) or PTD® system (Arrow-Trerotola). Stenting was performed for obstructive lesions causing ≥50% diameter narrowing in the inferior vena cava, iliac vein or common femoral vein.

The first phase of the endovenous procedure in CRS group was an angioplasty with balloons. Then, stents were placed in the sequelae veins to a landing zone below in a stenosis-free location.

Procedure failure meant obstructive thrombosis causing ≥50% diameter narrowing or complete occlusion in the vein and/or stent at the end of the procedure.

In the immediate postoperative period after both procedures, intermittent pneumatic compression was applied during hospitalization. After discharge, venous compression stockings were systematic. Post-procedure treatment included anti-platelet therapies for one month combined with therapeutic anticoagulation consisting of two periods: a three-week period with rivaroxaban 15 mg twice daily or tinzaparin 175 U/kg/day followed by therapeutic anticoagulation with rivaroxaban 20 mg once daily or vitamin K antagonist (VKA) therapy with an international normalized ratio (INR) target of 2 to 3.

Follow-up

The data were collected using a standardized grid. We collected both data before procedure (patient and venous thrombosis characteristics); types of procedure and data after the procedure (complications, venous and stent patency and clinical evaluation).

Clinical evaluation and systematic Duplex ultrasound were performed 1 day after the procedure and at 1 month, 3 months, 6 months, 1 year and once a year. Most of the patients with ilio-femoral stent had computed tomography (CT) at 1, 2 and 5 years after stenting and after inferior vena cava stenting another CT was performed at 6 months.

For venous patency data: primary patency was defined as anterograde flow with <50% stenosis on follow-up without any repeat endovenous procedure. Patency at the last follow-up defined as anterograde flow with <50% stenosis at the last follow-up with or without initial technical success or/and repeat endovenous procedure (10,14).

In case of thrombosis occurring within 14 days after stenting, pharmaco-mechanical thrombolysis was performed with flow assessment and if necessary, a new angioplasty-stenting.

In case of symptomatic stenosis or >50% stenosis, angioplasty with or without stenting was performed. In case of endovascular intervention failed, nor bypass either other surgery was performed.

For clinical evaluation: PTS defined as a Villalta score ≥5 at the last follow-up. Scores <5 indicate absence of PTS, a score of 5–9 indicates mild PTS, 10–14 indicates moderate PTS, and a Villalta score >15 indicates severe PTS (15).

The primary endpoint of the study was to compare venous patency between PMT and CRS. The secondary endpoints of the study were to compare procedure data; to compare procedure-related complications; to compare PTS; to compare clinical characteristics before and after procedure and to compare antiplatelet and anticoagulant therapy before and after procedure between PMT and CRS.

Ethical statement

This study has been conducted in compliance with the Declaration of Helsinki principles (as revised in 2013) and has received ethics board approval by GNEDS (Groupe Nantais d'Ethique et de Soins), the local ethics committee of the University Hospital of Nantes (GNEDS-20190606), and complied with the requirements of the "Commission Nationale de l'Informatique et des Libertés", in accordance with current French legislation. Informed consent was waived due to the retrospective nature of the medical record review.

Statistical analysis

The data were compared with the Fisher's exact test or a Chi-square test based on the number of patients to compare categorical variables and the Student's *t*-test to compare normally distributed continuous variables between groups. Cumulative probabilities of primary patency, patency at the last follow-up, continued anticoagulation, the occurrence of PTS and moderate to severe PTS were calculated using Kaplan-Meier method and the log-rank test was used for comparison curved. P value <0.05 was considered significant. GraphPad software was used to perform analyses (San Diego, USA).

Results

Clinical characteristics and location of venous damage

This study included 116 patients, 58.6% (n=68) were female with a median age of 42.5 years (range, 14–82 years) and a median follow-up of 27 months (range, 0–69 months).

Characteristics of patients and deep-vein thrombosis risk factors are summarized in *Table 1*.

Active cancers were more frequent in PMT group. Cancers diagnosed in the PMT group were ovarian, breast, lung with brain metastases and cervical. A left iliac vein leiomyosarcoma and a recurrence of ovarian cancer were diagnosed after DVT in the CRS group. *Table 2* shows, at the time of procedure, the extent of venous damage with the locations of vein thrombosis for PMT group and parietal venous sequelae for CRS group.

Stenting data

Endovenous procedure data are described in *Table 3*. Mean number of stents for each procedure was 2.0 [standard deviation (SD) ±1.1] in the PMT group and 3.1 (SD ±1.5) in the CRS group (P<0.001).

Procedure-related complications

Regarding procedure complications, there were in the PMT group one arteriovenous fistula (AVF), one combined AVF and false aneurysm, one psoas hematoma, one renal insufficiency secondary to rhabdomyolysis due to prolonged prone decubitus in obese patient and 5 symptomatic PE with one was fatal PE. In PMT group, five procedures were complicated by symptomatic PE. In these cases, four had vena cava thrombosis initially, 2 of which had PE despite the placement of a cava filter at the beginning of the procedure.

There were 19.2% PE in the PMT group *vs.* none in the CRS group (P<0.001). In the CRS group, there were 2 AVF, one patient had immediate hematoma at the puncture site, one thigh hematoma and two hematuria.

Venous patency

Cumulative rates of primary venous patency, venous patency

Table 1 Characteristics of patients and deep-vein thrombosis risk factors

Characteristics	PMT (n=26)	CRS (n=90)	P
Woman, n/n (%)	14/26 (53.8)	54/90 (60.0)	0.57
BMI (kg/m²), median [min–max]	25.4 [20.2–42.6]	25.2 [17.9–50.8]	0.79
Age in years, median [min–max]	37.0 [15.0–82.0]	45.5 [14.0–75.0]	0.39
Deep-vein thrombosis risk factors, n/n (%)			
Idiopathic VTED	9/26 (34.6)	40/90 (44.4)	0.37
May-Thurner	8/26 (30.8)	38/90 (42.2)	0.29
VTED during pregnancy	0/26 (0.0)	7/90 (7.8)	0.34
VTED in post-partum†	3/26 (11.5)	7/90 (7.8)	0.69
Venous catheter	1/26 (3.8)	0/90 (0.0)	0.22
Active cancer	4/26 (15.4)	2/90 (2.2)	0.02
Patient with at least one inherited thrombophilia	12/20 (60.0) (5 heterozygous V Leiden mutations; 3 protein S deficiencies; 2 heterozygous prothrombin G20210A mutations; 2 double heterozygous mutations of the factor II and V)	25/57 (43.9) (10 heterozygous factor V mutations; 6 heterozygous factor II mutations; 3 protein C deficiencies; 1 antithrombin deficiency; 2 homozygous factor V mutations; 2 combined antithrombin deficiencies and heterozygous factor V mutation; 1 combined protein S deficiency and heterozygous factor V mutation)	0.31
Antiphospholipid syndrome	4/22 (18.2)	4/65 (6.2)	0.11
Systemic diseases	2/26 (7.7) (2 rheumatoid arthritis)	7/90 (7.8) (2 rheumatoid arthritis; 2 Behçet's diseases; 1 retroperitoneal fibrosis; 1 lupus; 1 Sjogren's syndrome)	>0.99

†, during 3 months after delivery. BMI, body mass index; VTED, venous thrombo-embolic disease; PMT, pharmaco-mechanical catheter-directed thrombolysis; CRS, chronic venous obstruction treated with recanalization-stenting.

Table 2 Location of vein lesions at the time of procedure; vein thrombosis in PMT group and parietal venous sequelae in CRS group

Location	PMT (n=26), n/n (%)	CRS (n=90), n/n (%)	P
Left side	23/26 (88.5)	82/90 (91.1)	0.71
Bilatéral	6/26 (23.1)	22/90 (24.4)	0.88
Inferior vena cava	10/26 (38.5)	24/90 (26.7)	0.24
Iliac and/or common femoral vein	26/26 (100.0)	90/90 (100.0)	>0.99
Great saphenous vein	12/26 (46.2)	19/90 (21.1)	0.01
Femoral vein	25/26 (96.2)	42/90 (46.7)	<0.001
Deep femoral vein	20/26 (76.9)	19/90 (21.1)	<0.001
Popliteal and/or subpopliteal veins	17/26 (65.4)	7/90 (7.8)	<0.001

PMT, pharmaco-mechanical catheter-directed thrombolysis; CRS, chronic venous obstruction treated with recanalization-stenting.

at the last follow-up and anticoagulant therapy at the last follow-up are shown in *Figure 1*. The rate of primary patency was 81.8% (18/22 patients) in the PMT group and 78.4% (69/88) in the CRS group (P>0.99). The rate of venous patency at the last follow-up was 76.9% (20/26) in the PMT group and 82.2% (74/90) in the CRS group (P=0.57).

Two patients in the PMT group had second procedure

Table 3 Data on venous interventional procedures and venous stent locations

Variables	PMT (n=26)	CRS (n=90)	P
Procedure failure, n/n (%)	3/26 (11.5)	1/90 (1.1)	0.03
Number of stents, median [min–max]	2 [0–5]	3 [0–7]	<0.001
Stent length in mm, median [min–max]	150 [60–390]	280 [120–820]	<0.001
Proximal stenting zone, n/n (%)			
Cava	3/24 (12.5)	26/89 (29.2)	0.12
Common iliac	16/24 (66.7)	54/89 (60.7)	0.59
External iliac	5/24 (20.8)	9/89 (10.1)	0.17
Distal stenting zone, n/n (%)			
Cava	1/24 (4.2)	0/89 (0.0)	0.21
Common iliac	4/24 (16.7)	6/89 (6.7)	0.22
External iliac	6/24 (25.0)	14/89 (15.7)	0.37
Common femoral	11/24 (45.8)	37/89 (41.6)	0.71
Great saphenous vein	0/24 (0.0)	1/89 (1.1)	>0.99
Femoral vein	1/24 (4.2)	12/89 (13.5)	0.29
Deep femoral	0/24 (0.0)	19/89 (21.3)	0.01
Popliteal	1/24 (4.2)	0/89 (0.0)	0.21
Iliocaval bifurcation kissing stents, n/n (%)	0/25 (0.0)	23/89 (25.8)	0.003
Procedure-related complications, n/n (%)	9/26 (34.6)	6/90 (6.7)	<0.001
Median follow-up in months [min–max]	13 [0–40]	30 [0–69]	<0.001
Median follow-up between the endovenous procedure and the last Villalta score [min–max]	16 [3–40]	16 [0–67]	0.93

PMT, pharmaco-mechanical catheter-directed thrombolysis; CRS, chronic venous obstruction treated with recanalization-stenting.

after stent thrombosis with one being successful and the other failing. Sixteen patients had second procedure in the CRS group with fifteen successes and one failure. None stent fracture was described in the PMT group *vs.* 5 in the CRS group (P=0.58).

Anticoagulant treatment

After procedure, most of the patients had 3 weeks of rivaroxaban 30 mg/day then 20 mg/day or 4 weeks of tinzaparin 175 U/kg/day then VKA or direct oral anticoagulant (DOAC). The therapeutic anticoagulation regimen was the same after procedure for the patients managed in the PMT or in the CRS group. Initial therapeutic anticoagulation after procedure in the PMT and CRS group were 69.2% (18/26) of DOACs *vs.* 73.3% (66/90) respectively (P=0.68), 19.2% (5/26) of low molecular weight heparins (LMWHs) *vs.* 24.4% (22/90) respectively (P=0.79) and 11.5% (3/26) of unfractionated heparin (UFH) *vs.* none respectively (P=0.01). In the CRS group, one patient continued on VKA without switching and one patient received clopidogrel only. In the PMT group initially treated with heparin (LMWH or UFH), 14.3% (1/7) of patients were switched to VKAs, 42.9% (3/7) were switched to DOACs and 42.9% (3/7) remained on LMWH in the context of cancer. In the CRS group initially treated with LMWH, 54.5% of patients (12/22) were switched to VKAs, 36.4% (8/22) to DOACs, one patient remained on LMWH without switching due to pregnancy and one patient was lost to follow-up. In the PMT group, 73.1% (19/26) of patients received at least one month of antiplatelet therapy compared to 94.4% (84/89) in the

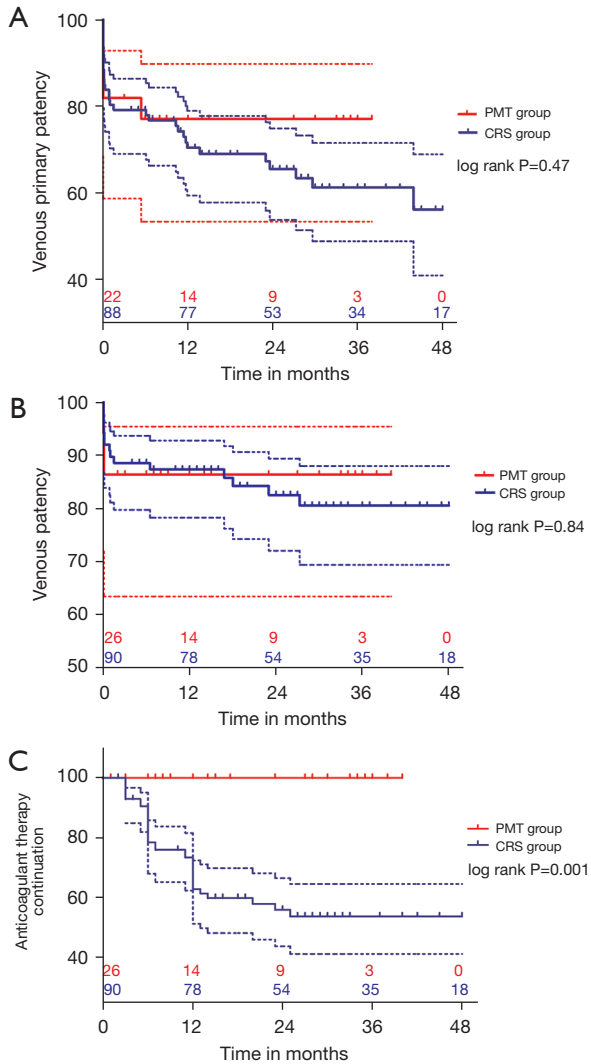

Figure 1 Kaplan-Meier survival curves of venous patency and for continuation of anticoagulant therapy. Numbers of patients at risk at given time intervals. Solid central lines are the Kaplan-Meier survival curves. The dashed lines represent the 95% confidence interval. (A) Kaplan-Meier survival curves of primary venous patency; (B) Kaplan-Meier survival curves of primary and secondary venous patency; (C) Kaplan-Meier survival curves for continuation of anticoagulant therapy. PMT, pharmaco-mechanical catheter-directed thrombolysis; CRS, chronic venous obstruction treated with recanalization-stenting.

CRS group (P=0.005). All patients in the PMT group had therapeutic anticoagulation at the last follow-up *vs.* 71.1% (64/90) in the CRS group (P<0.001). In patients continuing anticoagulation, 7/26 patients in the PMT group switched to half-dose of DOACs *vs.* 10/64 patients in the CRS

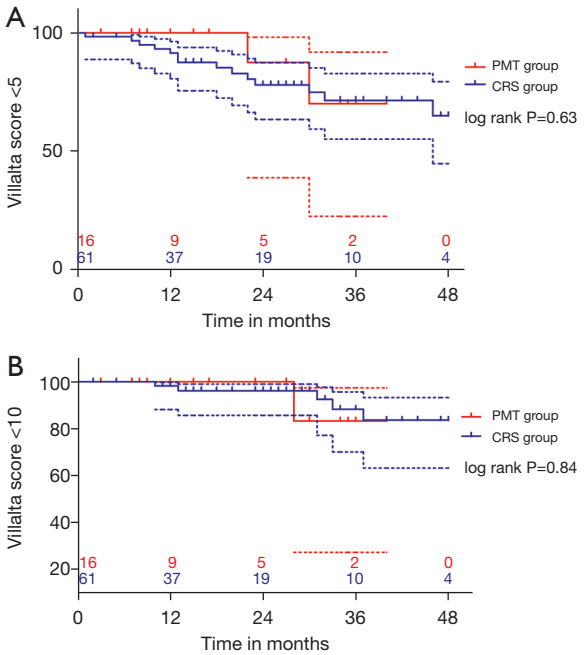

Figure 2 Kaplan-Meier survival curves of Villalta score. Numbers of patients at risk at given time intervals. Solid central lines are the Kaplan-Meier survival curves. The dashed lines represent the 95% confidence interval. (A) Kaplan-Meier survival curves of Villalta score <5; (B) Kaplan-Meier survival curves of Villalta score <10. PMT, pharmaco-mechanical catheter-directed thrombolysis; CRS, chronic venous obstruction treated with recanalization-stenting.

group (26.9% *vs.* 15.6%; P=0.24). The mean duration of anticoagulation was 17.0 (SD ±13.4) months in the PMT group and 17.9 (SD ±14.9) months in the CRS group (P=0.75).

PTS

The cumulative rates of Villalta score <5 and <10 at the last follow-up are shown in *Figure 2*. The median last Villalta score was 2 (range, 0–10) in the PMT group and 2 (range, 0–21) in the CRS group. The mean last Villalta score was 2.3 (SD ±2.7) in the PMT group and 3.2 (SD ±4.1) in the CRS group (P=0.55). The rate of venous claudication at the last follow-up was 19.0% (4/21) in the PMT group and 12.0% (10/83) in the CRS group (P=0.47).

Discussion

To our knowledge, this study is the largest comparing pharmaco-mechanical thrombolysis for the treatment of

acute DVT and recanalization-stenting for the treatment for chronic venous obstruction after lower limbs DVT.

In this study, there was no difference in venous patency, our primary endpoint, between the PMT and CRS groups. The rates of PTS were not different between the 2 groups. It also demonstrated that during PMT, fewer stents were implanted. Best anticoagulant treatment strategy after venous stenting is actually not known; and depend on numerous risk factors. Medical follow-up after the procedure to detect medium-term complications seems important for these patients.

Venous patency

In this study, there was no difference in venous patency between the PMT and CRS groups. The primary patency rate was 81.8% in our PMT group, this rate is described to vary from 64% to 96% (16-21). For recanalization-stenting in chronic obstructions, the primary patency rate in this study was 78.4% and it ranged from 59% to 85% in others studies (10-12,14,21-24).

Nevertheless, the procedure failure rate was significantly different; it was higher in the PMT group. In acute phase of DVT, local inflammation of the venous wall and systemic inflammation are additional thrombosis factors. Furthermore, in acute phase, patients are painful and decrease their walking time which further reduces venous flow. Acute thrombolysis studies reported procedure failure rates ranging from 4% to 14% (14-16,19). In recanalization-stenting for chronic obstruction, there is no systemic or parietal inflammation, only fibrous bands in the venous lumen. Thus, in these procedures, there is no more thrombus, which reduces the risk of embolization. The procedure failure rates ranged from 0 to 4% in studies on recanalization-stenting for chronic obstruction (10,14,24).

Stenting data

In the PMT group, the length and number of stents were lower than in the CRS group due to a less pathological venous wall. Indeed, in the acute phase, there is less wall synechia that require the placement of a stent. In acute procedure, stent is only inserted in the areas of compression/stenosis. In the acute phase of DVT, the distal vein wall below the obstacle does not have time to deteriorate, remodel and progress to fibrosis. This is in opposition to chronically occluded veins which became fibrous and require more stents to restore sufficient lumen and correct flow. In the literature, there were also fewer stents placed in acute thrombolysis with a mean of 1.1 stent placed in 2 studies (19,20) compared to a mean of 3.4 and median of 3 in studies of recanalization-stenting in chronic venous obstruction (10,14,24).

Procedure-related complications

There were 5 symptomatic PE following the procedure in our PMT group, one of them resulted in death, and none in the CRS group. This significant difference was explained by the presence of recent thrombus in proximal veins which was fragmented by thrombolysis and sometimes not aspirated by the device. This clot was able to embolise in pulmonary arteries despite the presence of a cava filter. In the literature, it is often difficult to distinguish between procedure-related PE and PE occurring during follow-up and not related to the procedure. However, it seems that PE are less frequent in studies of acute thrombolysis with rates of 0–5% (16-18,20) compared to our results. This difference could be explained by a systematic screening for signs of PE after each procedure in our study. On the other hand, as in our study, no PE was reported in several studies of recanalization-stenting in chronic obstruction (11,14,23,24).

Post thrombotic syndrome

There was no difference in the rate and severity of PTS; the median last Villalta score was 2 in both groups. In this venous interventional study, Villalta scores were very low corresponding to the absence of PTS. In literature, the mean Villalta score ranged from 3.1 to 4 at 12 months in acute thrombolysis studies (9,18). For recanalization-stenting in chronic venous obstructions, the median Villalta score was from 3 to 5 at 3 or 6 months (14,24).

Clinical characteristics

There were significantly more cancers in the PMT group which added a deep-vein thrombosis risk factor. In the literature 3% to 36% cancers were found after acute procedure (16,17,25-27) and for recanalization-stenting in chronic obstruction, the rate of cancer context ranged from 0 to 6% without specifying the disease activity at the time of recanalization (10,12,28). The small interval between diagnosis of DVT and acute procedure may explain this higher frequency since there is a limited time to perform

oncological explorations. Recanalization-stenting in chronic obstruction is offered after a period of several months. This allows oncologic screening and clinical evaluation of patients to identify asymptomatic cancer.

Anticoagulation after procedure

The number of patients with therapeutic anticoagulation at the last follow-up was significantly lower in the CRS group compared with the PMT group. One reason may be that patients in the CRS group, DVT and procedure were performed 6 months apart which allowed time for rigorous etiologic and thrombophilia explorations and allowed a better assessment of anticoagulation duration. However, interruption of anticoagulation treatment after acute thrombolysis appeared to be more frequent in the literature. In some studies, the rate of interruption ranged from 20% to 39% at 6 months and from 34% to 45% at 24 months (9,16). The maintenance of anticoagulation for our PMT patients could be explained by the lack of knowledge of risk factors for recurrence of DVT in patients with lower extremity venous stents and consideration of the wish of several patients to continue anticoagulation because of very symptomatic DVT with a major handicap initially. However, in order to limit the risk of bleeding, some patients had a half-dose reduction of anticoagulation by DOACs. This dose reduction was offered after a 1-year follow-up with perfect stent patency.

Limitations

This study has several limitations, it was retrospective and monocentric with limited follow-up time, Villalta score was not available for all patients. Moreover, the CRS venous lesion staging for patency prognosis, described by Menez *et al.* (24), was not available. Anticoagulation and antiplatelet regimens were not standardized for either type or duration of treatment, but most of the patients had a 4 weeks antiplatelet drug with therapeutic anticoagulant treatment. However, to our knowledge, it was the largest study to compare PMT for acute DVT and recanalization-stenting for chronic venous obstruction. Prospective and multicenter study is needed to confirm these results.

Conclusions

This study showed no difference in primary venous patency and at the last follow-up between PMT group and CRS group. Also, it showed no difference in the rate of PTS with a low Villalta score in the 2 groups. Nevertheless, the study showed more procedure-related complications in the PMT group, including more PE. However, stents placed in the PMT group were fewer and shorter but the impact on venous patency at long-term follow-up is not known. Thus, prospective studies with larger patient samples and longer follow-ups are required to compare PTS and to evaluate cost-effectiveness of vein interventional procedure after lower limbs DVT.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/qims-21-572). FD reports research funding from Cook medical, Optimed, WL Gore and personal fees and grants from Cook medical, Optimed, WL Gore (medical advisory board, educational course, speaking). YG reports research funding from Abbott, General Electric, Veryan, WL Gore and personal fees and grants from Abbott, Bard, Biotronik, Boston Scientic, Cook, General Electric, Medtronic, Penumbra, Terumo, Veryan, WL Gore (medical advisory board, educational course, speaking). BM reports consulting and proctoring fees from COOK medical and consulting fees from Philips Medical. OE reports research funding from Boston Scientific (Industry-Sponsored Research). The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study has been conducted in compliance with the Declaration of Helsinki principles (as revised in 2013) and has received ethics board approval by GNEDS (Groupe Nantais d'Ethique et de Soins), the local ethics committee of the University Hospital of Nantes (GNEDS-20190606), and complied with the requirements of the "Commission Nationale de l'Informatique et des Libertés", in accordance with current French legislation. Informed consent was waived due to the retrospective nature of the medical record review.

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