U.PORTO

MESTRADO INTEGRADO EM MEDICINA
ANGIOLOGIA E CIRURGIA VASCULAR

Intravascular Ultrasound in May-Thurner Syndrome: Diagnostic and Therapeutic Impact in a Retrospective Cohort

Pedro António Azevedo Menchaca

M

2026

Intravascular Ultrasound in May-Thurner Syndrome: Diagnostic and Therapeutic Impact in a Retrospective Cohort

-ARTIGO ORIGINAL DE INVESTIGAÇÃO-

Dissertação de Candidatura ao grau de Mestre em Medicina submetida ao Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto

Estudante: Pedro António Azevedo Menchaca

Número de estudante: 202004743

Correio eletrónico: up202004743@up.pt

Mestrado Integrado em Medicina

Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto, Porto, Portugal

Orientadora: Prof. Doutora Ivone Fernandes Santos da Silva

Professora Catedrática Convidada com Agregação do Instituto de Ciências Biomédicas Abel Salazar

Assistente Graduada Sénior do Serviço de Angiologia e Cirurgia Vascular, ULSSA Porto

Coorientadora: Dra. Ana Mónica Carvalho Bandeira

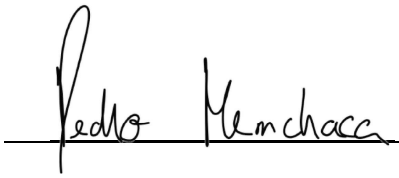
Interna de Formação específica de angiologia e cirurgia vascular do Serviço de Angiologia e Cirurgia Vascular, ULSSA Porto

Junho, 2026

Intravascular Ultrasound in May-Thurner Syndrome: Diagnostic and Therapeutic Impact in a Retrospective Cohort

-ARTIGO ORIGINAL DE INVESTIGAÇÃO-

Dissertação de Candidatura ao grau de Mestre em Medicina submetida ao Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto

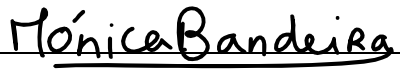


Pedro António Azevedo Menchaca

Assinado por: **Ivone Fernandes Santos da Silva**
Num. de Identificação: 11101263
Data: 2026.06.07 16:02:34+01'00'

CHAVE MÓVEL

Prof. Doutora Ivone Fernandes Santos da Silva



Dra. Ana Mónica Carvalho Bandeira

Junho, 2026

Declaração de integridade científica

Eu, Pedro António Azevedo Menchaca, declaro solenemente que esta dissertação, intitulada "Intravascular Ultrasound in May-Thurner Syndrome: Diagnostic and Therapeutic Impact in a Retrospective Cohort", é um trabalho original e genuíno. Durante o seu processo de investigação e elaboração, segui estritamente os princípios éticos e as normas académicas estabelecidas pela comunidade científica. Assumo total responsabilidade pelo conteúdo desta dissertação e estou ciente das possíveis consequências de qualquer violação dos princípios de integridade científica.

Pedro António Azevedo Menchaca

Dedicatória

Dedico este projeto de investigação à minha Mãe, à minha Avó Clara, ao meu Avô José e ao meu bisavô António.

Agradecimentos

A realização deste trabalho não teria sido possível sem o contributo e o apoio de várias pessoas, às quais devo um sincero reconhecimento.

À *Dra. Ivone Silva*, orientadora deste projeto, o meu mais profundo agradecimento. Pela disponibilidade sempre demonstrada, pelo rigor e qualidade do feedback transmitido em cada etapa, e pela confiança depositada no meu trabalho. Agradeço ainda a oportunidade de integrar o Serviço de Angiologia e Cirurgia Vascular, que me permitiu contactar de perto com uma área cirúrgica exigente e fascinante, contribuindo de forma determinante para a minha formação clínica.

À *Dra. Mónica Bandeira*, coorientadora deste projeto, agradeço a disponibilidade constante e o acompanhamento atento ao longo de todo o processo, que foram fundamentais para a concretização deste trabalho.

A toda a equipa do Serviço de Angiologia e Cirurgia Vascular do Centro Hospitalar Universitário de Santo António, um sincero obrigado pela forma calorosa e acolhedora com que sempre me receberam, e pelo ambiente de aprendizagem que proporcionaram.

À minha Mãe por ser o meu maior exemplo de vida. Agradeço-te por me ensinares a nunca desistir, a perseguir os meus sonhos, a encontrar a felicidade nos pequenos momentos, por me mostrares o Mundo e por seres a minha pedra basilar. Obrigado pelo apoio incondicional que me dás sempre e por celebrares comigo todas as pequenas vitórias ao longo da vida.

Aos meus queridos Avós, Avó Clara e Avô José, obrigado por estarem sempre presentes, por testemunharem todo o meu percurso de vida, por me ensinarem tanto. Agradeço todo o vosso esforço, empenho, carinho e dedicação no papel que tiveram na minha educação.

Ao meu querido irmão de quatro patas, Max, por ter acompanhado todo o meu percurso académico desde o ensino primário, por ter a capacidade de me acalmar sempre e me fazer sorrir.

Aos meus queridos amigos, por todo o apoio incondicional que me dão, por terem sempre uma palavra bonita e de ânimo.

Por último, uma palavra de gratidão ao ICBAS – *Instituto de Ciências Biomédicas Abel Salazar* e ao *Centro Hospitalar Universitário de Santo António*, que me acolheram e formaram ao longo de seis anos de medicina, proporcionando as condições necessárias para o desenvolvimento deste trabalho e da minha prática clínica.

Resumo

Introdução e objetivo: A obstrução venosa iliofemoral, incluindo a síndrome de May–Thurner, é cada vez mais tratada por stenting endovascular. O ultrassom intravascular (IVUS) afirmou-se como adjuvante de imagem para a deteção e o dimensionamento das lesões, mas o seu impacto nos resultados a médio e longo prazo permanece por esclarecer. Este estudo comparou os resultados do stenting venoso iliofemoral guiado por venografia isolada versus venografia combinada com IVUS.

Métodos: Coorte retrospetiva de 68 doentes submetidos a stenting venoso iliofemoral (36 [52,9%] com venografia isolada; 32 [47,1%] com venografia + IVUS). As comparações entre grupos recorreram aos testes de qui-quadrado/Fisher, t de Student/Mann–Whitney; os preditores de patência primária e de reintervenção foram avaliados por regressão logística e o tempo até perda de patência por regressão de Cox (análise não ajustada seguida de modelo multivariável para variáveis com $p<.10$). A patência cumulativa foi estimada por Kaplan–Meier com teste de log-rank; $\alpha=0.05$.

Resultados: A coorte foi predominantemente feminina (91,2%), com idade média de 42,9±13,0 anos e doença C3 predominante (63,2%). O tratamento consistiu sobretudo em stenting (88,2%), mais frequentemente na veia ilíaca comum esquerda (64,7%). A mediana de seguimento foi de 39,0 meses (IQR 12–56). A patência primária sem reintervenção manteve-se em 70,6% e a patência no último seguimento em 76,5%; a reintervenção foi necessária em 13,2%. O grupo de venografia isolada apresentou mais trombose venosa profunda prévia (61,1% vs 31,3%) e mais apresentações agudas. Nenhum desfecho de patência diferiu significativamente entre grupos (todos $p>.05$). Os três eventos de perda de patência ocorreram no grupo de venografia isolada (Kaplan–Meier 76,2% vs 100% aos 60 meses; log-rank $p=.218$). A colocação de ≥2 stents associou-se a menor patência primária (OR 0,26; CI 95% 0,07–0,99; $p=.049$) e a classe CEAP mais elevada à reintervenção (OR 2,20; CI 95% 1,02–4,73; $p=.044$); nenhuma variável se manteve significativa após ajuste multivariável.

Conclusão: Observou-se um sinal direcional consistentemente favorável ao IVUS em todos os desfechos de patência, embora as diferenças não tenham atingido significância estatística numa amostra de dimensão limitada e com desequilíbrios basais (maior carga trombótica no grupo de venografia isolada). Em conjunto com a evidência externa e o racional mecanístico do IVUS, estes resultados apoiam o seu papel como adjuvante de referência no stenting venoso iliofemoral.

Palavras-chave: síndrome de May–Thurner; obstrução venosa iliofemoral; ultrassom intravascular; stenting venoso; patência.

Abstract

Background and aim: Iliofemoral venous obstruction, including May–Thurner syndrome, is increasingly managed with endovascular stenting. Intravascular ultrasound (IVUS) has become an established imaging adjunct for lesion detection and stent sizing, yet its impact on medium- to long-term outcomes remains unclear. This study compared the outcomes of iliofemoral venous stenting guided by venography alone versus venography combined with IVUS.

Methods: Retrospective cohort of 68 patients undergoing iliofemoral venous stenting (36 [52.9%] venography alone; 32 [47.1%] venography + IVUS). Between-group comparisons used chi-square/Fisher and t/Mann–Whitney tests; predictors of primary patency and reintervention were assessed by logistic regression and time to loss of patency by Cox regression (unadjusted analysis followed by a multivariate model for variables with $p<0.10$). Cumulative patency was estimated by Kaplan–Meier with the log-rank test; $\alpha=.05$.

Results: The cohort was predominantly female (91.2%), with a mean age of 42.9±13.0 years and predominant C3 disease (63.2%). Treatment was mostly stenting (88.2%), most often of the left common iliac vein (64.7%). Median follow-up was 39.0 months (IQR 12–56). Primary patency without reintervention was 70.6% and patency at last follow-up 76.5%; reintervention was required in 13.2%. The venography-alone group had more prior DVT (61.1% vs 31.3%) and more acute presentations. No patency outcome differed significantly between groups (all $p>.05$). All three loss-of-patency events occurred in the venography-alone group (Kaplan–Meier 76.2% vs 100% at 60 months; log-rank $p=.218$). Implantation of ≥2 stents was associated with lower primary patency (OR 0.26; 95% CI 0.07–0.99; $p=.049$) and higher CEAP class with reintervention (OR 2.20; 95% CI 1.02–4.73; $p=.044$); no variable remained significant after multivariate adjustment.

Conclusion: A consistent directional signal favouring IVUS was observed across all patency outcomes, although differences did not reach statistical significance in a limited-size sample with baseline imbalances (greater thrombotic burden in the venography-alone group). Together with the external evidence and the mechanistic rationale for IVUS, these findings support its role as the reference imaging adjunct in iliofemoral venous stenting.

Keywords: May–Thurner syndrome; iliofemoral venous obstruction; intravascular ultrasound; venous stenting; patency.

Abbreviations

ACR – American College of Radiology

AVF – American Venous Forum

AVLS – American Vein and Lymphatic Society

CEAP – Clinical-Etiology-Anatomy-Pathophysiology

CI – Confidence Interval

CIV – Common Iliac Vein

CT – Computed Tomography

CTV – Computed Tomography Venography

DOAC – Direct Oral Anticoagulant

DVT – Deep Vein Thrombosis

EIV – External Iliac Vein

ESVS – European Society for Vascular Surgery

HR – Hazard Ratio

IQR – Interquartile Range

IVUS – Intravascular Ultrasound

LMWH – Low Molecular Weight Heparin

MLA – Minimum Luminal Area

MR – Magnetic Resonance

MRV – Magnetic Resonance Venography

MTS – May-Thurner Syndrome

N/A – Not Applicable

ND – Not Determined

NIVL – Non-Thrombotic Iliac Vein Lesion

OR – Odds Ratio

RIETE – Registro Informatizado de Enfermedad TromboEmbólica

SCAI – Society for Cardiovascular Angiography and Interventions

SD – Standard Deviation

SIR – Society of Interventional Radiology

SPSS – Statistical Package for the Social Sciences

SVM – Society for Vascular Medicine

SVS – Society for Vascular Surgery

ULSSA – Unidade Local de Saúde de Santo António

UTI – Urinary Tract Infection

VERNACULAR – Venovo EuRopean Non-inferiority triAl for Chronic Lower extremity venous revasculARization

VIDIO – Venogram vs IVUS for Diagnosing Iliac vein Obstruction

VIVA – VIVA Foundation

VKA – Vitamin K Antagonist

Index

List of tables

List of figures

Introduction

Iliofemoral venous obstruction is a major cause of chronic morbidity, producing substantial functional limitation and reduced quality of life. The most frequent manifestations include pain, heaviness, persistent lower-limb oedema, cutaneous changes secondary to chronic venous hypertension, and, in advanced cases, venous ulceration. Within this spectrum, May-Thurner Syndrome (MTS) is a distinct entity. A specific non-thrombotic iliac vein lesion (NIVL), it is defined by extrinsic compression of the left common iliac vein between the overlying pulsatile right common iliac artery and the underlying lumbar vertebral body [1].

Beyond impairing venous haemodynamics, the repetitive arterial pulsation causes chronic endothelial trauma, driving intimal hyperplasia and the formation of intraluminal spurs and fibrous webs. The resulting venous stasis and elevated pelvic pressure increase the risk of deep vein thrombosis (DVT), post-thrombotic syndrome, and symptomatic chronic venous insufficiency [2].

Although historically considered uncommon (2–5% of DVT episodes), the true prevalence of MTS is probably underestimated, owing to limited use of advanced pelvic imaging. Recent population-level data from the *Registro Informatizado de Enfermedad TromboEmbólica* (RIETE Registry) (2009–2024) identified MTS in 4.3% of patients with image-confirmed proximal DVT [3]. Affected patients were predominantly younger women (78% female; mean age 42 years vs 62 years in non-MTS proximal DVT) [3]. Despite fewer comorbidities, they had higher rates of recurrent thrombosis despite prolonged anticoagulation, identifying MTS as an independent predictor of recurrence (adjusted HR 2.26; 95% CI 1.02–5.01) [3].

Diagnostic evaluation has evolved with cross-sectional imaging. Guidelines recommend Computed Tomography Venography (CTV) or Magnetic Resonance Venography (MRV) for initial assessment, and the 2023 American College of Radiology Appropriateness Criteria highlight three-dimensional MRV for identifying stenoses, occlusions, and fibrous webs [4].

Even so, non-invasive imaging and contrast venography have important intrinsic limitations. The 2025 American Heart Association statement notes that duplex ultrasonography cannot directly visualise iliocaval lesions, inferring obstruction only from flow-waveform changes [5]. Comparative studies confirm this, reporting a Doppler sensitivity of only 58% and systematic underestimation of luminal area [6,7]. Contrast venography, the traditional intraoperative reference standard, is equally fallible: a two-dimensional projection of an inherently three-dimensional, often elliptical and eccentric vascular lumen, it underestimates stenosis severity, achieving a sensitivity of only 45% and a negative predictive value of 49% for stenoses exceeding 70% [8].

To overcome these constraints of projection-based imaging, intravascular ultrasound (IVUS) has become the *de facto* standard of care in interventional phlebology [9,10]. Through real-time 360-degree intraluminal imaging, it allows objective measurement of the minimum luminal area (MLA). The multicentre VIDIO trial showed that IVUS detects 30% more haemodynamically significant lesions (≥50% area reduction) than venography alone [9].

This diagnostic superiority has prompted a broad shift in practice, endorsed by several international societies. The 2024 SCAI/AVF/AVLS/SIR/SVM/SVS consensus deemed IVUS appropriate across all phases of deep venous intervention [11], a position further endorsed by the 2024 VIVA/AVF/AVLS consensus on the management of non-thrombotic iliac vein lesions [12] and reinforced by the 2023 European Society for Vascular Surgery (ESVS) clinical practice guidelines, which formally recommend IVUS for diagnosis, pre-stenting assessment, and post-procedural confirmation in iliac venous obstruction [13]. The anatomical precision afforded by IVUS carries direct procedural implications: observational data show that venography and IVUS agree on the location of the distal landing zone in only 26% of cases, and on the iliocaval confluence in a mere 15% [10]. IVUS can also identify dynamic compressive lesions that vary with respiration and positioning, reducing the subjectivity of venography-guided assessment.

IVUS also refines stent sizing. Undersizing and poor wall apposition are leading causes of early stent thrombosis and migration; objective measurement of the inflow channel helps select devices with the radial force and geometry needed to cover the full extent of disease [14].
Outcomes after IVUS-guided treatment of MTS are consistently favourable: in the dedicated nitinol stent era, technical success rates of 97–100% are reported [15,16]. The prospective multicentre VERNACULAR study demonstrated primary patency of 93.6% at 36 months in the non-thrombotic iliac vein lesion subgroup [15]. Symptomatic recurrence nonetheless remains a concern: residual stenosis ≥50% after the index procedure independently predicts reduced long-term patency (HR 5.04; 95% CI 1.28–19.82) [17], and inadequate venous inflow is strongly associated with recurrence (adjusted OR 38.02; 95% CI 3.76–384.20) [18]. These findings underscore that complete anatomical resolution, verified intraoperatively by IVUS, is the decisive determinant of durable procedural success.

Despite this accumulating evidence and societal endorsement, routine IVUS use remains uneven worldwide. In Portugal, access in deep venous surgery is confined to a few specialised referral centres, so iliac vein interventions are often still guided by venography alone. This reflects well-documented barriers to adoption — most notably the high unit cost of disposable catheters, limited reimbursement within healthcare systems, and the requirement for dedicated operator training [19]. The clinical and therapeutic impact of this technological gap on the

Portuguese patient population — particularly with regard to intraoperative technical success rates and medium- to long-term stent patency — has yet to be systematically quantified.

The primary objective of this study was to compare the medium- to long-term outcomes of iliofemoral venous stenting guided by venography alone versus venography combined with IVUS, with stent patency as the principal endpoint. The secondary objectives were to characterise the demographic, clinical, and procedural profile of the treated cohort; to compare technical success, stent patency, stent failure, and reintervention between the two imaging strategies; and to identify clinical, procedural, and morphometric predictors of primary patency, loss of patency, and reintervention. By analysing this institutional cohort, the study sought to generate local evidence to inform resource allocation and improve clinical outcomes.

Materials and methods

This was a retrospective, single-centre observational cohort study conducted at the *Department of Angiology and Vascular Surgery of the Unidade Local de Saúde de Santo António* (ULSSA), Porto, including all consecutive patients treated by endovascular venous stenting for chronic iliofemoral venous obstruction due to May–Thurner syndrome or a non-thrombotic iliac vein lesion between January 2020 and December 2025. Eligible patients were adults with symptomatic disease classified by the CEAP system and treated by stenting, with or without adjunctive angioplasty or catheter-directed thrombolysis; patients with malignant compression, isolated infrainguinal disease, previous ipsilateral stenting, or insufficient documentation were excluded. The final cohort comprised 68 patients, of whom 36 (52.9%) were treated under venographic guidance alone and 32 (47.1%) under venography combined with intravascular ultrasound (IVUS); allocation was not randomised and reflected the progressive institutional adoption of IVUS over the study period. The study was conducted in accordance with the Declaration of Helsinki and the RGPD and was approved by the institutional Ethics Committee *[2025.310 (268 – CAC- 268- CE)]*, which waived the requirement for informed consent given the retrospective use of anonymised data.

Preoperative assessment included clinical evaluation, CEAP classification, and non-invasive imaging (duplex ultrasonography, computed tomography angiography or venography, and/or magnetic resonance venography). All procedures were performed under ultrasound-guided venous access and multiplanar contrast venography; in the IVUS group, an intraluminal pullback was used to characterise lesion morphology, measure the minimum luminal area, define the landing zones, and identify haemodynamically significant lesions (≥50% area reduction). Treatment consisted predominantly of dedicated venous nitinol stent implantation,

sized according to venographic and, where available, IVUS measurements, with adjunctive balloon angioplasty or thrombolysis as indicated and completion imaging to confirm adequate expansion, apposition, and inflow. Antithrombotic therapy (DOAC, LMWH, or VKA) was individualised, and patients were followed clinically and by duplex ultrasonography. Data collected comprised demographic, clinical, imaging, procedural, and device variables, and the predefined outcomes of technical success, primary patency, patency at last follow-up, stent thrombosis or occlusion, stent failure, reintervention, and ulcer healing.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics, Version 31 (IBM Corp., Armonk, NY). Statistical significance was set at $\alpha = 0.05$ (two-tailed) for all tests.

Baseline characteristics were compared between the venography-alone and venography + IVUS groups. Categorical variables were analyzed using the chi-square test of independence; effect size was quantified using phi (ϕ) for 2 × 2 tables and Cramér's V for tables with more than two categories. For continuous variables, group differences were assessed using the independent-samples *t*-test (effect size: Cohen's *d*) or the Mann-Whitney *U* test when the normality assumption was not met. Variables with categories absent in one or both groups were excluded from statistical analysis.

Predictors of primary patency were examined using binary logistic regression. Unadjusted models were first estimated for each candidate variable; those achieving $p < 0.10$ were entered into a multivariate model. Results are expressed as odds ratios (OR) with 95% confidence intervals (CI).

Predictors of follow-up patency were assessed using Cox proportional hazards regression, following the same two-stage approach — unadjusted analysis followed by a multivariate model including variables with $p < 0.10$. Results are expressed as hazard ratios (HR) with 95% CI. In addition, cumulative patency over time was estimated using the Kaplan-Meier method, stratified by type of procedure, with group comparison performed via the log-rank test. Predictors of reintervention were analyzed using binary logistic regression, applying the same selection procedure. Results are expressed as OR with 95% CI. Variables with zero-cell frequencies in outcome categories were excluded from the corresponding models and are reported as not applicable (N/A).

Results

A total of 68 patients were included in the study, of whom 36 (52.9%) underwent intervention guided by venography alone and 32 (47.1%) underwent venography combined with IVUS. The overall cohort was predominantly female (91.2%), with a mean age of 42.9 ± 13.0 years and a mean body mass index of 25.3 ± 4.5 kg/m². Most patients had no pregnancy history (66.2%), while 11.8% had one previous pregnancy and 13.2% had two or more pregnancies. Hormonal contraception or hormone therapy was documented in 23.5% of patients. Documented thrombophilia (2.9%) and active or previous neoplasia (1.5%) were uncommon.

Regarding thrombotic history, 47.1% of patients had a previous documented DVT. Most patients presented with chronic symptoms (80.9%), whereas acute and mixed presentations accounted for 14.7% and 4.4% of cases, respectively. According to the CEAP classification, C3 disease was the predominant clinical stage (63.2%), followed by C4 (11.8%) and C2 (8.8%), while active venous ulcers were rare (4.4%).

Venous collaterals were identified in 35.3% of patients, most commonly of pelvic origin. Symptomatically, pain, tension, heaviness, or tingling and limb edema were present in 69.1% of patients, whereas venous claudication was reported in 20.6%. Pelvic symptoms or dyspareunia and varicose veins were present in 20.6% of patients, while venous stasis was observed in 39.7%. Computed tomography angiography was the most frequently used diagnostic modality (48.5%), followed by CT venography (25.0%) and duplex ultrasonography (11.8%). Treatment consisted predominantly of stent implantation (88.2%), with additional angioplasty performed in 4.4% and thrombolysis plus stenting in 7.4%. Among stented patients, a single stent was implanted in 69.1% of cases, most commonly with a proximal diameter of 16 mm (44.1%) and a proximal stent length of 100 mm (45.6%). The most frequent anatomical location of stenting was the left common iliac vein (64.7%).

Periprocedural complications were infrequent, occurring in only 5.9% of patients. Most patients remained hospitalized for at least two days after the procedure (58.8%). Imaging follow-up was performed in 70.6% of patients, primarily using duplex ultrasonography alone or in combination with other imaging modalities. The median follow-up duration was 39.0 months (IQR 12.0–56.0). During follow-up, primary patency without reintervention was maintained in 70.6% of patients, and stent patency at the last available follow-up was documented in 76.5%. Stent thrombosis or occlusion occurred in 10.3% of patients, stent failure in 14.7%, and reintervention was required in 13.2% of cases.

Comparison between imaging groups demonstrated that most demographic, clinical, procedural, and outcome variables were similarly distributed between patients treated with venography alone and those treated with venography plus IVUS. Significant differences were observed only

for number of pregnancies (p = 0.049, V = 0.33), prior DVT history (p = 0.046, ϕ = −0.26), presentation phenotype (p = 0.039, V = 0.31), type of treatment performed (p = 0.014, V = 0.34), and distal stent length (p = 0.003, V = 0.82).

Specifically, patients undergoing venography alone more frequently had a history of prior DVT (61.1% vs. 31.3%) and acute presentation (22.2% vs. 6.3%), whereas patients treated with venography plus IVUS more frequently reported one or more previous pregnancies and included all patients with mixed clinical presentations. Stenting combined with angioplasty was performed exclusively in the IVUS group (9.4%), while thrombolysis plus stenting was restricted to the venography-alone group (13.9%). Distal stent length distributions also differed between groups, although distal stenting was not applicable to most patients.

Despite these baseline and procedural differences, no significant differences were observed between groups regarding primary patency, patency at last follow-up, stent thrombosis or occlusion, stent failure, need for reintervention, or ulcer healing (all p > .05). However, given the limited sample size and low number of events, the study may be underpowered to detect clinically meaningful differences between imaging strategies.

Univariate associations

Univariate analyses (Tables II–IV) examined the associations between baseline demographic, clinical, imaging, procedural, and treatment-related variables and the three outcomes of interest — primary patency, time to loss of patency, and reintervention — using binary logistic regression or Cox proportional hazards models, as appropriate to the outcome. To ensure stable and interpretable estimates, variables with very low category frequencies, sparse distribution across outcome groups, or structural zero cells were excluded, as these produce unstable or non-estimable models in a cohort of this size; the analyses were therefore restricted to variables with adequate variability and distribution.

In the univariate analysis of primary patency (Table II), most variables showed no significant association (all p > 0.05). Notably, the addition of IVUS to venography was not significantly associated with primary patency (OR 1.90; 95% CI 0.49–7.36; p = 0.352), although the point estimate favoured IVUS. Sex, age, body mass index, pregnancy history, hormonal therapy, prior DVT, presentation phenotype, venous collaterals, symptom profile, stent dimensions, post-procedural hospital stay, and anticoagulant regimen at discharge or maintenance were likewise not associated with primary patency.

The only variable significantly associated with primary patency was the number of stents implanted: patients receiving two or more stents had markedly lower odds of maintaining primary patency than those receiving a single stent (OR 0.26; 95% CI 0.07–0.99; p = 0.049). Accordingly, multiple stents had been implanted in 54.5% of patients who lost primary patency, compared with 23.4% of those who maintained it.

Higher CEAP class showed a non-significant trend toward lower odds of primary patency (OR 0.51 per class; 95% CI 0.25–1.05; p = 0.067), consistent with less favourable patency in more advanced chronic venous disease.

Several further variables showed positive but non-significant point estimates: hormonal or oral contraceptive therapy (OR 3.86) and the presence of varicose veins (OR 3.33) were each associated with higher odds of primary patency. The wide confidence intervals and non-significant p-values indicate substantial uncertainty around all of these estimates.

In the univariate Cox analysis of time to loss of patency (Table III), no variable reached significance, although two showed borderline associations: older age at the procedure (HR 1.13 per year; 95% CI 0.99–1.28; p = 0.061) and higher CEAP class (HR 2.48; 95% CI 0.99–6.21; p = 0.052), both indicating a greater hazard of patency loss with advancing age and disease severity. Several variables could not be evaluated because all events were confined to a single group, yielding non-estimable hazard ratios: all three losses of patency occurred in the venography-alone arm, and none occurred among patients with pelvic symptoms or dyspareunia, venous claudication, or varicose veins. These patterns are hypothesis-generating and warrant confirmation in larger cohorts.

No significant associations were observed for sex (HR = 3.71, 95% CI 0.32–42.64, p = 0.293), body mass index (HR = 1.03, 95% CI 0.83–1.27, p = 0.795), presentation phenotype (acute versus chronic disease: HR = 2.33, 95% CI 0.21–26.03, p = 0.492), symptom burden, number of stents implanted (HR = 4.26, 95% CI 0.38–47.39, p = 0.239), proximal stent diameter (16 mm versus 14 mm: HR = 1.12, 95% CI 0.10–12.37, p = .925), duration of hospitalization (HR = 0.77, 95% CI 0.07–8.55, p = 0.830), anticoagulant therapy prescribed at discharge, or maintenance anticoagulant regimen (all p > 0.05).

Reintervention was required in 9 patients (13.2% of the cohort; 14.3% of those with available data). In the univariate analysis (Table IV), most variables were not significantly associated with this outcome.

The only significant predictor was CEAP class: higher CEAP was associated with greater odds of reintervention (OR 2.20; 95% CI 1.02–4.73; p = 0.044), indicating more frequent reintervention in advanced chronic venous disease.

Three variables showed non-significant trends: two or more stents (OR 3.65; 95% CI 0.84–15.84; p = 0.084) and one previous pregnancy (OR 4.80; 95% CI 0.82–28.15; p = 0.082) toward higher odds of reintervention, and a 100-mm versus 80-mm proximal stent length toward lower odds (OR 0.12; 95% CI 0.01–1.31; p = 0.082).

The addition of IVUS again showed a non-significant trend toward fewer reinterventions (OR 0.50; 95% CI 0.11–2.23; p = 0.364). The remaining variables — including sex, age, body mass index, prior DVT, presentation phenotype, symptom burden, stent diameter, hospital stay, and anticoagulant regimen — were not associated with reintervention (all p > .05).

Multivariate analysis

Candidate variables with p < 0.10 in the univariate analyses (Tables II–IV) were entered into multivariable models for each outcome. This less stringent threshold was chosen to avoid prematurely excluding potentially relevant predictors, in keeping with the exploratory design and the limited number of events; the models were kept parsimonious to preserve stability and avoid overfitting.

In the multivariable model for primary patency (Table V), no variable retained significance. Higher CEAP class remained associated with lower odds of primary patency at borderline significance (OR 0.50; 95% CI 0.23–1.07; p = 0.074), and the effect of two or more stents was attenuated and no longer significant (OR 0.30; 95% CI 0.07–1.32; p = 0.113).

In the multivariable Cox model for loss of patency (Table VI), which included age and CEAP class, neither variable reached significance. Age remained borderline (HR 1.17 per year; 95% CI 0.98–1.34; p = 0.089), corresponding to an estimated 17% increase in the hazard of patency loss per additional year, while CEAP class was not independently associated after adjustment for age (HR 2.74; 95% CI 0.81–9.23; p = 0.105).

Cumulative patency by imaging strategy is shown in Table VII and Figure 1. In the venography-alone group, patency was 100% through 36 months, then declined to 85.7% at 48 months and 76.2% at 60 months, remaining stable thereafter to the end of follow-up (74 months). In the IVUS group, patency remained 100% throughout the observation period (to 57 months), with no loss-of-patency event.

Despite the numerically higher patency in the IVUS group, the difference was not statistically significant (log-rank p = 0.218); the curves are therefore consistent with, but do not establish, a long-term advantage of IVUS-guided stenting.

In the multivariable model for reintervention (Table VIII), no variable reached significance. One previous pregnancy showed a borderline association (OR 4.97; 95% CI 0.76–32.56; p = 0.095), whereas CEAP class (OR 1.52; 95% CI 0.59–3.90; p = 0.384) and two or more stents (OR 1.71; 95% CI 0.28–10.44; p = 0.563) were not independently associated; the univariate associations were thus attenuated after adjustment.

Discussion

The principal finding of this cohort is consistent in direction. Across every clinically relevant endpoint examined — primary patency, cumulative patency at last follow-up, stent thrombosis or occlusion, stent failure, and reintervention — outcomes were numerically more favourable in the IVUS-guided group than in patients treated with venography alone. No single difference reached statistical significance, but the concordance of five separate endpoints in the same direction is unlikely to be wholly incidental, and the most plausible explanation for the absence of significance is the small number of events rather than a true absence of effect.

Primary patency was 78.1% versus 63.9% (OR 1.90; 95% CI 0.49–7.36); reintervention was required in 9.4% versus 16.7% (OR 0.50; 95% CI 0.11–2.23); and stent failure occurred in 9.4% versus 19.4%. Of note, no patency loss event occurred in the IVUS arm, whereas all three events were recorded in the venography-alone group. None of these differences, taken individually, reached statistical significance. Nevertheless, the convergence of five separate outcomes in the same direction warrants consideration — particularly when the most plausible explanation for the lack of significance is the small number of events rather than a true absence of effect.

What the external evidence tells us

These findings do not stand alone. The VIDIO trial — a prospective, multicentre study specifically designed to compare multiplanar venography with venography plus IVUS in 100 patients with advanced chronic venous disease — documented results that help explain what is observed here.[9] Venography identified stenotic lesions in 51 patients; IVUS found them in 81. On average, venography underestimated diameter reduction by 11% (P <0.001). Perhaps most telling of all, the investigators revised their treatment plan in 57 of 100 cases after performing IVUS — and in 41 of those 57, no procedure at all would have been carried out based on venography alone.[9] These findings have direct implications for the present cohort. If venography systematically misses lesions and underestimates their severity, it is reasonable to expect that venography-only guidance may produce less durable outcomes than those achieved with the additional anatomical information that IVUS provides.

Other data reinforce this picture. Venography and IVUS agree on the location of the distal landing zone in only 26% of cases, and on the iliocaval confluence in a mere 15%.[10] For stenoses exceeding 70%, venography achieves a sensitivity of only 45% and a negative predictive value of 49% when compared against intraluminal assessment.[8] These differences are clinically meaningful and reflect a known limitation of two-dimensional projection imaging when applied to a vessel that is often elliptical, eccentric, and subject to dynamic compression.

Why the mechanism supports these findings

The pathophysiological rationale is well established. May-Thurner syndrome is defined by anteroposterior compression — precisely the component of venous anatomy that venography, as a planar technique, is least equipped to capture. IVUS, imaging from within the vessel, provides a 360-degree cross-sectional view that allows direct measurement of the minimum luminal area, accurate identification of proximal and distal landing zones, and more appropriate stent sizing. These translate into potential procedural advantages: undersizing a stent in an iliac vein — which IVUS may help prevent — creates conditions that favour peri-stent thrombosis and device migration.[14] Published data show that residual stenosis of 50% or more after the index procedure independently predicts reduced long-term patency (HR 5.04; 95% CI 1.28–19.82),[17] while inadequate venous inflow is strongly associated with recurrent disease (adjusted OR 38.02; 95% CI 3.76–384.20).[18] In this context, the directional advantage observed for IVUS in this cohort is consistent with what the mechanistic rationale would suggest, even if the data available are insufficient to establish it formally.

Independent predictors of outcome

The predictor analyses add further nuance. The placement of two or more stents was the only variable independently associated with reduced primary patency (OR 0.26; 95% CI 0.07–0.99; p =0.049), likely serving as a proxy for more extensive or complex disease rather than as a direct cause of failure. This association was attenuated after multivariate adjustment, which suggests that part of its effect is mediated through clinical severity. In keeping with this, higher CEAP class was independently associated with the need for reintervention (OR 2.20; 95% CI 1.02–4.73; p =0.044) — a finding that is clinically intuitive and consistent with the published literature. Of note, age emerged as a borderline independent predictor of time to patency loss in the multivariate Cox model (HR 1.17; 95% CI 0.98–1.34; p =0.089). An estimated 17% increase in the hazard of patency loss per additional year of age, while not statistically conclusive, is biologically plausible with advancing age, venous wall compliance declines, comorbidity accumulates, and

the systemic milieu becomes more prothrombotic. Whether this finding reflects a true age effect or residual confounding by disease severity cannot be determined from these data alone, but it seems worth investigating in larger series.

Interpretation of the survival curves

Figure 1 shows cumulative patency over time by imaging strategy. For roughly the first 40 months the two curves are almost superimposed; thereafter the venography-alone arm declines in a stepwise fashion to approximately 76% at 60 months, while the IVUS arm remains at 100% throughout. The visual separation is suggestive, but the log-rank test returned $p = 0.218$, well short of conventional significance.

The reason lies in the structure of the data rather than the p-value alone. The entire separation between the curves is driven by two to three events, and beyond 48 months the censoring marks become dense, indicating that few patients remained under observation; the tail estimates are therefore statistically fragile and should not be overinterpreted. The comparison is further conditioned by an asymmetry in follow-up: the IVUS arm was observed to a maximum of about 57 months, against roughly 74 months in the venography-alone arm. The 100% patency of the IVUS group thus reflects a shorter observation window, so the two arms are not compared over the same horizon at the far end of the curve, and part of the apparent difference at 60 months is a structural artefact rather than a confirmed biological advantage. The baseline imbalance in prior DVT, addressed separately, could on its own account for some of the late events in the venography arm. Figure 1 is therefore best read as hypothesis-generating with respect to a long-term advantage of IVUS-guided stenting, not as confirmation of one.

The confounding role of prior deep vein thrombosis

Any between-group comparison in this study must be read in light of a clear difference in baseline disease burden. The venography-alone group entered the analysis with substantially more prior DVT (61.1% versus 31.3%; $p = 0.046$) and a higher proportion of acute presentations. This distribution was not the result of randomisation; it reflects the real-world, non-uniform adoption of IVUS over the study period, during which the technique was initially applied more selectively. As a consequence, the two groups differ not only in imaging strategy but also in the severity of the disease being treated.

Prior DVT is a well-established determinant of post-thrombotic venous wall remodelling, intraluminal fibrosis, and chronically impaired haemodynamic. All three patency loss events

occurred in the venography-alone group, and they were concentrated in patients with a prior thrombotic history. The poorer outcomes in that arm may therefore reflect, at least in part, its greater underlying disease severity rather than — or in addition to — less precise intraoperative guidance. These two influences cannot be fully separated with observational data of this scale; a propensity-matched or stratified analysis would be required to isolate the effect of imaging modality, but the small number of events makes that approach unfeasible. This case-mix difference is the central consideration in interpreting the comparison, and the directional advantage of IVUS should be read with it firmly in mind.

Comparison with other studies

The patency rates in this cohort are reasonable when read against the published literature and the case-mix treated. Overall primary patency was 70.6% (78.1% in the IVUS group and 63.9% in the venography-alone group), in a population in which 47.1% had a prior deep vein thrombosis and post-thrombotic disease was therefore well represented — a group in whom outcomes are consistently worse than in purely non-thrombotic lesions. The VERNACULAR trial reported primary patency of 93.6% at 36 months, but specifically in the non-thrombotic iliac vein lesion subgroup,[15] a more homogeneous population that sets a deliberately favourable benchmark; the lower rates seen here are consistent with the greater thrombotic burden of an unselected, real-world cohort followed for a median of 39 months. Technical success of 100% matches the performance of dedicated nitinol venous stent platforms in contemporary practice.[15,16]

The guideline trajectory is unambiguous. The 2024 SCAI/AVF/AVLS/SIR/SVM/SVS consensus established IVUS as the appropriate imaging adjunct across all phases of deep venous intervention,[11] a position shared by the 2024 VIVA/AVF/AVLS consensus on non-thrombotic iliac vein lesions[12] and by the 2023 ESVS clinical practice guidelines.[13] Against this background, the present study contributes real-world outcome data from a Portuguese tertiary centre — a setting in which IVUS access remains confined to a few referral units and comparative data of this kind are scarce.

Limitations

This study has several limitations beyond the confounding already discussed. Its retrospective, single-centre design constrains both internal validity and generalisability. With 68 patients, three patency-loss events, and nine reinterventions, it was underpowered to detect modest between-group differences, as reflected in the wide confidence intervals and several

non-estimable parameters of the multivariable models. CEAP was modelled as a continuous variable, an assumption of ordinal linearity that might not capture the clinical heterogeneity between disease stages. Follow-up was incomplete in about a third of patients and relied on heterogeneous imaging modalities, introducing potential ascertainment bias in the determination of patency.

Finally, because the study period coincided with the introduction and progressive uptake of IVUS, the groups differ temporally as well as by imaging strategy: earlier patients were more often in the venography-alone arm, and operator experience evolved over time. These limitations do not negate the observed signal, but together they preclude any causal conclusion.

Conclusion

In this single-centre retrospective cohort, IVUS-guided iliofemoral venous stenting was associated with consistently better outcomes across every patency-related endpoint, although no difference reached statistical significance in a small sample with few events and a baseline excess of post-thrombotic disease in the venography-alone group. This case-mix imbalance cannot be resolved with the available data and precludes any causal inference. Nonetheless, the direction of effect is concordant with the mechanistic rationale for intraluminal imaging and with the available trial, guideline, and consensus evidence,[9,11,12,13] which together establish that IVUS provides anatomical information that venography alone cannot. These findings should therefore be read as supporting, rather than independently demonstrating, a benefit of routine IVUS guidance. Adequately powered prospective studies with balanced groups are needed to quantify that benefit and to separate the effect of imaging from that of patient selection; until then, our data add real-world support, from a setting where IVUS access remains limited, to its role as the reference imaging adjunct in deep venous intervention.

References

1. Cockett FB, Thomas ML. The iliac compression syndrome. Br J Surg. 1965;52(10):816-821.

2. Harbin MM, Lutsey PL. May-Thurner syndrome: history of understanding and need for defining population prevalence. J Thromb Haemost. 2020;18(3):534-542.

3. Varona JF, Ochoa Chaar CI, Pedrajas JM, et al. Clinical characteristics and impact of May-Thurner syndrome in patients with proximal deep vein thrombosis: insights from the RIETE Registry. Angiology. 2025;76(1):45-53.

4. Rochon PJ, Reghunathan A, Kapoor BS, et al. ACR Appropriateness Criteria® lower extremity chronic venous disease. J Am Coll Radiol. 2023;20(11S):S481-S500.

5. Li W, Vedantham S, Jaffer FA, et al. Revisiting the open vein hypothesis to reduce the postthrombotic syndrome: a scientific statement from the American Heart Association. Circulation. 2025;151(23):e1051-e1071.

6. Müller M, Wolf F, Loewe C, et al. Preprocedural imaging modalities in patients undergoing iliocaval venous recanalization and stent placement. Vasc Med. 2023;28(4):315-323.

7. Raju S, Walker W, Noel C, Kuykendall R, Powell T, Jayaraj A. Dimensional disparity between duplex and intravascular ultrasound in the assessment of iliac vein stenosis. Vasc Med. 2021;26(5):549-555.

8. Neglén P, Raju S. Intravascular ultrasound scan evaluation of the obstructed vein. J Vasc Surg. 2002;35(4):694-700.

9. Gagne PJ, Tahara RW, Fastabend CP, et al. Venography versus intravascular ultrasound for diagnosing and treating iliofemoral vein obstruction (VIDIO Trial). J Vasc Surg Venous Lymphat Disord. 2017;5(5):678-687.

10. Montminy ML, Thomasson JD, Tanaka GJ, Lamanilao LM, Crim W, Raju S. A comparison between intravascular ultrasound and venography in identifying key parameters essential for iliac vein stenting. J Vasc Surg Venous Lymphat Disord. 2019;7(6):801-807.

11. Secemsky EA, Aronow HD, Kwolek CJ, et al. Intravascular ultrasound use in peripheral arterial and deep venous interventions: multidisciplinary expert opinion from SCAI/AVF/AVLS/SIR/SVM/SVS. J Soc Cardiovasc Angiogr Interv. 2024;3(1):101205.

12. Desai KR, Sabri SS, Elias S, et al. Consensus statement on the management of nonthrombotic iliac vein lesions from the VIVA Foundation, the American Venous Forum, and the American Vein and Lymphatic Society. Circ Cardiovasc Interv. 2024;17(8):e014160.

13. Kakkos SK, Gohel M, Baekgaard N, et al. Editor's choice — European Society for Vascular Surgery (ESVS) 2023 clinical practice guidelines on the management of chronic venous disease of the lower limbs. Eur J Vasc Endovasc Surg. 2023;65(2):231-320.

14. Jayaraj A, Thaggard D, Lucas M. Technique of stent sizing in patients with symptomatic chronic iliofemoral venous obstruction — the case for intravascular ultrasound-determined inflow channel luminal area-based stenting and associated long-term outcomes. J Vasc Surg Venous Lymphat Disord. 2023;11(3):634-641.
15. Dake MD, O'Sullivan G, Shammas NW, Lichtenberg M, Mwipatayi BP, Settlage RA. Three-year results from the Venovo venous stent study for the treatment of iliac and femoral vein obstruction. Cardiovasc Intervent Radiol. 2021;44(12):1918-1929.
16. Shammas NW, Radaideh Q, Shammas G, et al. Venovo venous stent in treating iliac vein compression: a single-center experience. J Invasive Cardiol. 2021;33(9):E677-E680.
17. Oh CH, Nam IC, Kim DR, et al. Prognostic factors influencing venous patency after thrombectomy in patients with May-Thurner syndrome. PLoS One. 2025;20(11):e0336037.
18. Bondarev S, Keller EJ, Han T, et al. Predictors of disease recurrence after venoplasty and stent placement for May-Thurner syndrome. J Vasc Interv Radiol. 2019;30(10):1549-1554.
19. Secemsky EA, Parikh SA, Kohi M, et al. Intravascular ultrasound guidance for lower extremity arterial and venous interventions. EuroIntervention. 2022;18(7):598-608.

Tables

Table I. *Patient`s characteristics compared by type of procedure*

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
Patient sex				Fisher	0.203	ϕ = -0.19
Female	62 (91.2%)	31 (86.1%)	31 (96.9%)			
Male	6 (8.8%)	5 (13.9%)	1 (3.1%)			
Age at procedure (years)	42.9 (13.0) n=68	43.5 (14.1) n=36	42.3 (11.7) n=32	t(66) = 0.39	0.701	d = 0.09
Body mass index (kg/m²)	25.3 (4.5) n=68	26.1 (4.7) n=36	24.4 (4.2) n=32	t(66) = 1.49	0.141	d = 0.36
Number of pregnancies				Fisher	0.049*	V = 0.33
0	45 (66.2%)	27 (75.0%)	18 (56.3%)			
1	8 (11.8%)	2 (5.6%)	6 (18.8%)			
≥ 2	9 (13.2%)	2 (5.6%)	7 (21.9%)			
ND	6 (8.8%)	5 (13.9%)	1 (3.1%)			
Oral contraceptive or hormonal therapy				$\chi^2(1) = 0.44$	0.567	ϕ = 0.09
No	43 (63.2%)	23 (63.9%)	20 (62.5%)			
Yes	16 (23.5%)	7 (19.4%)	9 (28.1%)			
ND	9 (13.2%)	6 (16.7%)	3 (9.4%)			
Documented thrombophilia				Fisher	> 0.999	ϕ = 0.02
No	61 (89.7%)	34 (94.4%)	27 (84.4%)			
Yes	2 (2.9%)	1 (2.8%)	1 (3.1%)			
ND	5 (7.4%)	1 (2.8%)	4 (12.5%)			
Active neoplasia or in remission				Fisher	> 0.999	ϕ = -0.11
No	62 (91.2%)	34 (94.4%)	28 (87.5%)			
Yes	1 (1.5%)	1 (2.8%)	0 (0.0%)			
ND	5 (7.4%)	1 (2.8%)	4 (12.5%)			
Prior documented DVT history				$\chi^2(1) = 4.56$	0.046*	ϕ = -0.26
No	33 (48.5%)	14 (38.9%)	19 (59.4%)			
Yes	32 (47.1%)	22 (61.1%)	10 (31.3%)			
ND	3 (4.4%)	0 (0.0%)	3 (9.4%)			
Presentation phenotype				Fisher	0.039*	V = 0.31
Chronic	55 (80.9%)	28 (77.8%)	27 (84.4%)			
Acute	10 (14.7%)	8 (22.2%)	2 (6.3%)			
Mixed	3 (4.4%)	0 (0.0%)	3 (9.4%)			
ND	0 (0.0%)	0 (0.0%)	0 (0.0%)			
Clinical CEAP classification				Fisher	0.914	V = 0.16
C0	4 (5.9%)	2 (5.6%)	2 (6.3%)			
C1	0 (0.0%)	0 (0.0%)	0 (0.0%)			
C2	6 (8.8%)	4 (11.1%)	2 (6.3%)			
C3	43 (63.2%)	20 (55.6%)	23 (71.9%)			
C4	8 (11.8%)	5 (13.9%)	3 (9.4%)			
C5	2 (2.9%)	1 (2.8%)	1 (3.1%)			
C6	3 (4.4%)	2 (5.6%)	1 (3.1%)			

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
ND	2 (2.9%)	2 (5.6%)	0 (0.0%)			
Preoperative active venous ulcer				Fisher	> 0.999	ϕ = -0.07
No	62 (91.2%)	31 (86.1%)	31 (96.9%)			
Yes	3 (4.4%)	2 (5.6%)	1 (3.1%)			
ND	3 (4.4%)	3 (8.3%)	0 (0.0%)			
Venous collaterals on imaging				$\chi^2(1) = 1.94$	0.198	ϕ = -0.18
No	39 (57.4%)	19 (52.8%)	20 (62.5%)			
Yes	24 (35.3%)	16 (44.4%)	8 (25.0%)			
ND	5 (7.4%)	1 (2.8%)	4 (12.5%)			
Type of venous collaterals				Fisher	0.301	V = 0.52
Pelvic	11 (16.2%)	8 (22.2%)	3 (9.4%)			
Suprapubic/Transpubic	2 (2.9%)	1 (2.8%)	1 (3.1%)			
Abdominal wall	2 (2.9%)	2 (5.6%)	0 (0.0%)			
Other	2 (2.9%)	0 (0.0%)	2 (6.3%)			
Multiple	5 (7.4%)	4 (11.1%)	1 (3.1%)			
N/A	6 (8.8%)	5 (13.9%)	1 (3.1%)			
ND	40 (58.8%)	16 (44.4%)	24 (75.0%)			
Pain, tension, heaviness, or tingling				$\chi^2(1) = 0.34$	0.606	ϕ = -0.07
Absent	21 (30.9%)	10 (27.8%)	11 (34.4%)			
Present	47 (69.1%)	26 (72.2%)	21 (65.6%)			
Limb edema				$\chi^2(1) = 0.34$	0.606	ϕ = -0.07
Absent	21 (30.9%)	10 (27.8%)	11 (34.4%)			
Present	47 (69.1%)	26 (72.2%)	21 (65.6%)			
Venous claudication				$\chi^2(1) = 2.10$	0.229	ϕ = 0.18
Absent	54 (79.4%)	31 (86.1%)	23 (71.9%)			
Present	14 (20.6%)	5 (13.9%)	9 (28.1%)			
Pelvic symptoms or dyspareunia				$\chi^2(1) = 0.06$	> 0.999	ϕ = 0.03
Absent	54 (79.4%)	29 (80.6%)	25 (78.1%)			
Present	14 (20.6%)	7 (19.4%)	7 (21.9%)			
Varicose veins				$\chi^2(1) = 0.12$	0.772	ϕ = -0.04
Absent	54 (79.4%)	28 (77.8%)	26 (81.3%)			
Present	14 (20.6%)	8 (22.2%)	6 (18.8%)			
Venous stasis				$\chi^2(1) = 1.30$	0.323	ϕ = 0.14
Absent	41 (60.3%)	24 (66.7%)	17 (53.1%)			
Present	27 (39.7%)	12 (33.3%)	15 (46.9%)			
Main diagnostic method				Fisher	0.513	V = 0.27
CT angiography	33 (48.5%)	18 (50.0%)	15 (46.9%)			
CT venography	17 (25.0%)	8 (22.2%)	9 (28.1%)			
Duplex ultrasonography	8 (11.8%)	4 (11.1%)	4 (12.5%)			
Phlebography	5 (7.4%)	4 (11.1%)	1 (3.1%)			
MR angiography	2 (2.9%)	0 (0.0%)	2 (6.3%)			
Other	1 (1.5%)	1 (2.8%)	0 (0.0%)			

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
ND	2 (2.9%)	1 (2.8%)	1 (3.1%)			
Type of treatment performed				Fisher	0.014*	V = 0.34
Conservative	0 (0.0%)	0 (0.0%)	0 (0.0%)			
Stenting	60 (88.2%)	31 (86.1%)	29 (90.6%)			
Stenting + Angioplasty	3 (4.4%)	0 (0.0%)	3 (9.4%)			
Thrombolysis + Stenting	5 (7.4%)	5 (13.9%)	0 (0.0%)			
ND	0 (0.0%)	0 (0.0%)	0 (0.0%)			
Stent manufacturer				Fisher	0.471	ϕ = 0.13
Sinus/Optimed	67 (98.5%)	36 (100.0%)	31 (96.9%)			
Medtronic Abre	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Number of stents placed				$\chi^2(1) = 0.43$	0.592	ϕ = -0.08
1	47 (69.1%)	23 (63.9%)	24 (75.0%)			
≥ 2	19 (28.0%)	11 (30.6%)	8 (25.0%)			
ND	2 (2.9%)	2 (5.6%)	0 (0.0%)			
Proximal stent diameter (mm)				$\chi^2(2) = 3.00$	0.233	V = 0.21
14	10 (14.7%)	7 (19.4%)	3 (9.4%)			
16	30 (44.1%)	17 (47.2%)	13 (40.6%)			
18	25 (36.8%)	10 (27.8%)	15 (46.9%)			
ND	3 (4.4%)	2 (5.6%)	1 (3.1%)			
Proximal stent length (mm)				$\chi^2(3) = 5.54$	0.143	V = 0.29
80	14 (20.6%)	10 (27.8%)	4 (12.5%)			
100	31 (45.6%)	12 (33.3%)	19 (59.4%)			
120	12 (17.6%)	8 (22.2%)	4 (12.5%)			
≥ 140	9 (13.2%)	4 (11.1%)	5 (15.6%)			
ND	2 (2.9%)	2 (5.6%)	0 (0.0%)			
Distal stent diameter (mm)				Fisher	0.790	V = 0.25
12	6 (8.8%)	4 (11.1%)	2 (6.3%)			
14	12 (17.6%)	6 (16.7%)	6 (18.8%)			
18	1 (1.5%)	1 (2.8%)	0 (0.0%)			
N/A	49 (72.1%)	25 (69.4%)	24 (75.0%)			
Distal stent length (mm)				Fisher	0.003**	V = 0.82
60	1 (1.5%)	0 (0.0%)	1 (3.1%)			
80	5 (7.4%)	0 (0.0%)	5 (15.6%)			
100	8 (11.8%)	6 (16.7%)	2 (6.3%)			
120	4 (5.9%)	4 (11.1%)	0 (0.0%)			
180	1 (1.5%)	1 (2.8%)	0 (0.0%)			
N/A	49 (72.1%)	25 (69.4%)	24 (75.0%)			
Third stent diameter (mm)				—	—	—
14	1 (1.5%)	1 (2.8%)	0 (0.0%)			
N/A	67 (98.5%)	35 (97.2%)	32 (100.0%)			
Third stent length (mm)				—	—	—
80	1 (1.5%)	1 (2.8%)	0 (0.0%)			

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
N/A	67 (98.5%)	35 (97.2%)	32 (100.0%)			
Anatomical location of stenting				Fisher	0.255	V = 0.32
Left CIV	44 (64.7%)	25 (69.4%)	19 (59.4%)			
Left CIV + EIV	11 (16.2%)	3 (8.3%)	8 (25.0%)			
Left iliofemoral	5 (7.4%)	2 (5.6%)	3 (9.4%)			
Iliocaval	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Right CIV	3 (4.4%)	2 (5.6%)	1 (3.1%)			
Femoro-iliocaval	2 (2.9%)	2 (5.6%)	0 (0.0%)			
ND	2 (2.9%)	2 (5.6%)	0 (0.0%)			
Intraoperative anticoagulation				—	—	—
Sodium heparin	52 (76.5%)	22 (61.1%)	30 (93.8%)			
ND	16 (23.5%)	14 (38.9%)	2 (6.3%)			
Periprocedural complication				Fisher	> 0.999	ϕ = 0.01
No	63 (92.6%)	33 (91.7%)	30 (93.8%)			
Yes	4 (5.9%)	2 (5.6%)	2 (6.3%)			
ND	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Type of complication				Fisher	> 0.999	V = 1.00
Hematoma	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Hematuria/UTI	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Stent migration	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Rethrombosis	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)			
ND	64 (94.1%)	34 (94.4%)	30 (93.8%)			
Post-procedure hospital stay (days)				$\chi^2(1) = 1.07$	0.439	ϕ = 0.13
1	24 (35.3%)	14 (38.9%)	10 (31.3%)			
≥ 2	40 (58.8%)	18 (50.0%)	22 (68.8%)			
ND	4 (5.9%)	4 (11.1%)	0 (0.0%)			
Anticoagulant prescribed at discharge (1st phase)				Fisher	0.166	V = 0.27
LMWH	24 (35.3%)	16 (44.4%)	8 (25.0%)			
Rivaroxaban	30 (44.1%)	13 (36.1%)	17 (53.1%)			
Apixaban	8 (11.8%)	3 (8.3%)	5 (15.6%)			
VKA	1 (1.5%)	1 (2.8%)	0 (0.0%)			
ND	5 (7.4%)	3 (8.3%)	2 (6.3%)			
Maintenance anticoagulant				Fisher	0.678	V = 0.17
LMWH	13 (19.1%)	8 (22.2%)	5 (15.6%)			
Rivaroxaban	34 (50.0%)	16 (44.4%)	18 (56.3%)			
Apixaban	15 (22.1%)	8 (22.2%)	7 (21.9%)			
VKA	1 (1.5%)	1 (2.8%)	0 (0.0%)			
ND	5 (7.4%)	3 (8.3%)	2 (6.3%)			
Antiplatelet therapy prescribed at discharge				Fisher	> 0.999	ϕ = 0.01
No	61 (89.7%)	32 (88.9%)	29 (90.6%)			
Yes	4 (5.9%)	2 (5.6%)	2 (6.3%)			

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
ND	3 (4.4%)	2 (5.6%)	1 (3.1%)			
Imaging follow-up performed				Fisher	> 0.999	ϕ = -0.03
No	12 (17.6%)	6 (16.7%)	6 (18.8%)			
Yes	48 (70.6%)	26 (72.2%)	22 (68.8%)			
ND	8 (11.8%)	4 (11.1%)	4 (12.5%)			
Imaging modality at follow-up				Fisher	0.895	V = 0.26
Duplex ultrasonography	20 (29.4%)	10 (27.8%)	10 (31.3%)			
CT angiography	7 (10.3%)	3 (8.3%)	4 (12.5%)			
CT venography	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Phlebography	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Multiple	18 (26.5%)	10 (27.8%)	8 (25.0%)			
MR angiography	1 (1.5%)	1 (2.8%)	0 (0.0%)			
ND	20 (29.4%)	11 (30.6%)	9 (28.1%)			
Primary patency (without reintervention)				$\chi^2(1) = 0.89$	0.506	ϕ = 0.12
No	11 (16.2%)	7 (19.4%)	4 (12.5%)			
Yes	48 (70.6%)	23 (63.9%)	25 (78.1%)			
ND	9 (13.2%)	6 (16.7%)	3 (9.4%)			
Patency at last follow-up				Fisher	0.238	ϕ = 0.23
Occlusion	3 (4.4%)	3 (8.3%)	0 (0.0%)			
Patent	52 (76.5%)	26 (72.2%)	26 (81.3%)			
ND	13 (19.1%)	7 (19.4%)	6 (18.8%)			
Total follow-up time (months)	39.0 (12.0-56.0) n=68	40.0 (22.5-58.5) n=36	36.5 (11.5-56.0) n=32	U = 326	0.149	—
Stent thrombosis or occlusion				Fisher	0.424	ϕ = -0.15
No	49 (72.1%)	24 (66.7%)	25 (78.1%)			
Yes	7 (10.3%)	5 (13.9%)	2 (6.3%)			
ND	12 (17.6%)	7 (19.4%)	5 (15.6%)			
Stent failure (composite outcome)				Fisher	0.299	ϕ = -0.17
No	46 (67.6%)	22 (61.1%)	24 (75.0%)			
Yes	10 (14.7%)	7 (19.4%)	3 (9.4%)			
ND	12 (17.6%)	7 (19.4%)	5 (15.6%)			
Need for reintervention				Fisher	0.476	ϕ = -0.12
No	48 (70.6%)	24 (66.7%)	24 (75.0%)			
Yes	9 (13.2%)	6 (16.7%)	3 (9.4%)			
ND	11 (16.2%)	6 (16.7%)	5 (15.6%)			
Reason for reintervention				Fisher	0.762	V = 0.58
Thrombosis/Occlusion	6 (8.8%)	4 (11.1%)	2 (6.3%)			
Restenosis/Crush	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Stent migration	1 (1.5%)	0 (0.0%)	1 (3.1%)			
Thrombolysis control	0 (0.0%)	0 (0.0%)	0 (0.0%)			
Symptoms	1 (1.5%)	1 (2.8%)	0 (0.0%)			
N/A	33 (48.5%)	21 (58.3%)	12 (37.5%)			
ND	26 (38.2%)	9 (25.0%)	17 (53.1%)			

	Total	Venography alone (n = 36)	Venography + IVUS (n = 32)	Statistic	p	Effect size
Venous ulcer healing				Fisher	> 0.999	ϕ = 0.33
No	1 (1.5%)	1 (2.8%)	0 (0.0%)			
Yes	3 (4.4%)	2 (5.6%)	1 (3.1%)			
N/A	49 (72.1%)	25 (69.4%)	24 (75.0%)			
ND	15 (22.1%)	8 (22.2%)	7 (21.9%)			
Time to ulcer healing (weeks)				Fisher	> 0.999	ϕ = -1.00
30	1 (1.5%)	0 (0.0%)	1 (3.1%)			
45	1 (1.5%)	1 (2.8%)	0 (0.0%)			
ND	66 (97.1%)	35 (97.2%)	31 (96.9%)			

Note. Values are presented as mean (standard deviation) for normally distributed continuous variables, median (interquartile range) for non-normally distributed continuous variables, and n (%) for categorical variables. Statistical comparisons between groups were performed using independent samples *t*-tests, Mann-Whitney *U* tests, Pearson chi-square tests, or Fisher's exact tests, as appropriate. Categories with missing data were excluded from statistical analyses. Effect sizes are reported as Cohen's *d* for *t*-tests, phi (ϕ) for 2 × 2 chi-square comparisons, and Cramér's *V* for chi-square comparisons with more than two categories. No effect size is reported for Mann-Whitney *U* tests. IVUS = intravascular ultrasound; DVT = deep vein thrombosis; LMWH = low molecular weight heparin; VKA = vitamin K antagonist; DOAC = direct oral anticoagulant; CEAP = Clinical-Etiology-Anatomy-Pathophysiology; VCSS = Venous Clinical Severity Score; N/A = not applicable; ND = not determined; ‡ Approaches statistical significance ($p < 0.10$); * Statistically significant ($p < 0.05$), **p<0.01, ***p<0.001

Table II. *Associations with primary patency via logistic regression*

	Primary patency = no (n = 11)	Primary patency = yes (n = 48)	OR	95% CI	p-value
Type of procedure					
Venography alone	7 (63.6%)	23 (47.9%)	Ref.	—	—
Venography + IVUS	4 (36.4%)	25 (52.1%)	1.90	0.49 – 7.36	0.352
Patient sex					
Female	10 (90.9%)	45 (93.8%)	Ref.	—	—
Male	1 (9.1%)	3 (6.3%)	0.67	0.06 – 7.09	0.737
Age at procedure (years)	43.6 (17.8) n=11	40.8 (11.4) n=48	0.98	0.93 – 1.03	0.495
Body mass index (kg/m²)	25.2 (4.7) n=11	25.2 (4.7) n=48	1.00	0.87 – 1.16	0.977
Number of pregnancies					
0	7 (70.0%)	31 (68.9%)	Ref.	—	—
1	3 (30.0%)	5 (11.1%)	0.38	0.07 – 1.96	0.246
≥ 2	0 (0.0%)	9 (20.0%)	N/A	N/A	N/A
Oral contraceptive or hormonal therapy					
No	8 (88.9%)	29 (67.4%)	Ref.	—	—
Yes	1 (11.1%)	14 (32.6%)	3.86	0.44 – 33.98	0.223
Prior documented DVT history					
No	4 (36.4%)	24 (52.2%)	Ref.	—	—
Yes	7 (63.6%)	22 (47.8%)	0.52	0.14 – 2.04	0.351
Presentation phenotype					0.740
Chronic	8 (72.7%)	39 (81.3%)	Ref.	—	—
Acute	2 (18.2%)	7 (14.6%)	0.72	0.12 – 4.12	0.710
Mixed	1 (9.1%)	2 (4.2%)	0.41	0.03 – 5.09	0.488
Clinical CEAP classification	3.0 (3.0-4.0) n=10	3.0 (3.0-3.0) n=48	0.51	0.25 – 1.05	0.067‡
Venous collaterals on imaging					
No	6 (54.5%)	27 (61.4%)	Ref.	—	—
Yes	5 (45.5%)	17 (38.6%)	0.76	0.20 – 2.87	0.680
Pain, tension, heaviness, or tingling					0.900
Absent	3 (27.3%)	14 (29.2%)	Ref.	—	—
Present	8 (72.7%)	34 (70.8%)	0.91	0.21 – 3.94	0.900
Limb edema					0.395
Absent	2 (18.2%)	15 (31.3%)	Ref.	—	—
Present	9 (81.8%)	33 (68.8%)	0.49	0.09 – 2.54	0.395
Venous claudication					0.529
Absent	8 (72.7%)	39 (81.3%)	Ref.	—	—
Present	3 (27.3%)	9 (18.8%)	0.61	0.14 – 2.79	0.529
Pelvic symptoms or dyspareunia					N/A
Absent	11 (100.0%)	37 (77.1%)	Ref.	—	—
Present	0 (0.0%)	11 (22.9%)	N/A	N/A	N/A
Varicose veins					.274
Absent	10 (90.9%)	36 (75.0%)	Ref.	—	—
Present	1 (9.1%)	12 (25.0%)	3.33	0.39 – 28.82	0.274
Number of stents placed					
1	5 (45.5%)	36 (76.6%)	Ref.	—	—
≥ 2	6 (54.5%)	11 (23.4%)	0.26	0.07 – 0.99	0.049*
Proximal stent diameter (mm)					0.432
14	1 (10.0%)	8 (17.0%)	Ref.	—	—
16	8 (80.0%)	19 (40.4%)	0.30	0.03 – 2.78	0.287
18	1 (10.0%)	20 (42.6%)	2.50	0.14 – 45.01	0.534
Proximal stent length (mm)					
80	3 (27.3%)	9 (19.1%)	Ref.	—	—
100	2 (18.2%)	24 (51.1%)	4.00	0.57 – 28.01	0.163
120	3 (27.3%)	8 (17.0%)	0.89	0.14 – 5.72	0.901
≥ 140	3 (27.3%)	6 (12.8%)	0.67	0.10 – 4.48	0.677
Post-procedure hospital stay (days)					
1	4 (36.4%)	16 (34.0%)	Ref.	—	—
≥ 2	7 (63.6%)	31 (66.0%)	1.11	0.28 – 4.35	0.884
Anticoagulant prescribed at discharge (1st phase)					
LMWH	4 (36.4%)	17 (35.4%)	Ref.	—	—
Rivaroxaban	5 (45.5%)	24 (50.0%)	1.13	0.26 – 4.83	0.870
Apixaban	1 (9.1%)	7 (14.6%)	1.65	0.15 – 17.47	0.679
VKA	1 (9.1%)	0 (0.0%)	N/A	N/A	N/A
Maintenance anticoagulant					
LMWH	1 (9.1%)	11 (22.9%)	Ref.	—	—
Rivaroxaban	7 (63.6%)	26 (54.2%)	0.34	0.04 – 3.08	0.336
Apixaban	2 (18.2%)	11 (22.9%)	0.50	0.04 – 6.35	0.593
VKA	1 (9.1%)	0 (0.0%)	N/A	N/A	N/A

Note. Values are presented as mean (SD) for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables, and n (%) for categorical variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated via

binary logistic regression with primary patency (yes vs. no) as the outcome. Each variable was entered separately in unadjusted models. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical analyses. N/A = not applicable (OR could not be computed due to zero observed events in one or both groups). IVUS = intravascular ultrasound; LMWH = low molecular weight heparin; VKA = vitamin K antagonist; CEAP = Clinical-Etiology-Anatomy-Pathophysiology; ǂ Approaches statistical significance ($p < .10$); * Statistically significant ($p < 0.05$), **$p<0.01$, ***$p<0.001$

***Table III**. Associations with time to loss of patency at follow up via Cox regression*

	Loss of patency at follow up = yes (n = 3)	Loss of patency at follow up = no (n = 52)	HR	95% CI	p-value
Type of procedure					
Venography alone	3 (100%)	26 (50.0%)	Ref.	—	—
Venography + IVUS	0 (0%)	26 (50.0%)	N/A	N/A	N/A
Patient sex					
Female	2 (66.7%)	49 (94.2%)	Ref.	—	—
Male	1 (33.3%)	3 (5.8%)	3.71	0.32 – 42.64	0.293
Age at procedure (years)	59.7 (16.2) n=3	40.0 (11.6) n=52	1.13	0.99 – 1.28	0.061‡
Body mass index (kg/m²)	27.1 (4.7) n=3	25.2 (4.8) n=52	1.03	0.83 – 1.27	0.795
Number of pregnancies					
0	2 (100.0%)	34 (69.4%)	Ref.	—	—
1	0 (0.0%)	6 (12.2%)	N/A	N/A	N/A
≥ 2	0 (0.0%)	9 (18.4%)	N/A	N/A	N/A
Oral contraceptive or hormonal therapy					
No	2 (100.0%)	32 (68.1%)	Ref.	—	—
Yes	0 (0.0%)	15 (31.9%)	N/A	N/A	N/A
Prior documented DVT history					
No	0 (0.0%)	27 (52.9%)	Ref.	—	—
Yes	3 (100.0%)	24 (47.1%)	N/A	N/A	N/A
Presentation phenotype					
Chronic	2 (66.7%)	42 (80.8%)	Ref.	—	—
Acute	1 (33.3%)	8 (15.4%)	2.33	0.21 – 26.03	.492
Mixed	0 (0.0%)	2 (3.8%)	N/A	N/A	N/A
Clinical CEAP classification	5.0 (3.0-6.0) n=3	3.0 (3.0-3.0) n=52	2.48	0.99 – 6.21	0.052‡
Venous collaterals on imaging					
No	0 (0.0%)	31 (63.3%)	Ref.	—	—
Yes	3 (100.0%)	18 (36.7%)	N/A	N/A	N/A
Pain, tension, heaviness, or tingling					
Absent	2 (66.7%)	15 (28.8%)	Ref.	—	—
Present	1 (33.3%)	37 (71.2%)	0.23	0.02 – 2.62	0.239
Limb edema					
Absent	1 (33.3%)	15 (28.8%)	Ref.	—	—
Present	2 (66.7%)	37 (71.2%)	0.69	0.06 – 7.57	0.759
Venous claudication					
Absent	3 (100.0%)	42 (80.8%)	Ref.	—	—
Present	0 (0.0%)	10 (19.2%)	N/A	N/A	N/A
Pelvic symptoms or dyspareunia					N/A
Absent	3 (100.0%)	42 (80.8%)	Ref.	—	—
Present	0 (0.0%)	10 (19.2%)	N/A	N/A	N/A
Varicose veins					
Absent	3 (100.0%)	39 (75.0%)	Ref.	—	—
Present	0 (0.0%)	13 (25.0%)	N/A	N/A	N/A
Number of stents placed					
1	1 (33.3%)	38 (74.5%)	Ref.	—	—
≥ 2	2 (66.7%)	13 (25.5%)	4.26	0.38 – 47.39	0.239
Proximal stent diameter (mm)					
14	1 (33.3%)	8 (16.0%)	Ref.	—	—
16	2 (66.7%)	22 (44.0%)	1.12	0.10 – 12.37	0.925
18	0 (0.0%)	20 (40.0%)	N/A	N/A	N/A
Proximal stent length (mm)					
80	0 (0.0%)	12 (23.5%)	Ref.	—	—
100	1 (33.3%)	23 (45.1%)	N/A	N/A	N/A
120	1 (33.3%)	10 (19.6%)	N/A	N/A	N/A
≥ 140	1 (33.3%)	6 (11.8%)	N/A	N/A	N/A
Post-procedure hospital stay (days)					
1	1 (33.3%)	17 (33.3%)	Ref.	—	—
≥ 2	2 (66.7%)	34 (66.7%)	0.77	0.07 – 8.55	0.830
Anticoagulant prescribed at discharge (1st phase)					
LMWH	1 (33.3%)	20 (38.5%)	Ref.	—	—
Rivaroxaban	1 (33.3%)	24 (46.2%)	0.37	0.02 – 6.04	0.485
Apixaban	0 (0.0%)	8 (15.4%)	N/A	N/A	N/A
VKA	1 (33.3%)	0 (0.0%)	N/A	N/A	N/A
Maintenance anticoagulant					
LMWH	1 (33.3%)	11 (21.2%)	Ref.	—	—
Rivaroxaban	1 (33.3%)	28 (53.8%)	0.21	0.01 – 3.51	0.278
Apixaban	0 (0.0%)	13 (25.0%)	N/A	N/A	N/A
VKA	1 (33.3%)	0 (0.0%)	N/A	N/A	N/A

Note. Values are presented as mean (SD) for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables, and n (%) for categorical variables. Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated via

unadjusted Cox proportional hazards regression with loss of patency at follow-up as the event of interest. Each variable was entered separately in unadjusted models. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical analyses. N/A = not applicable (HR could not be computed due to zero observed events in one or both groups). IVUS = intravascular ultrasound; LMWH = low molecular weight heparin; VKA = vitamin K antagonist; CEAP = Clinical-Etiology-Anatomy-Pathophysiology; ‡ Approaches statistical significance ($p < .10$); * Statistically significant ($p < 0.05$), **$p<0.01$, ***$p<0.001$

Table IV. *Associations with reintervention via logistic regression*

	Reintervention = no (n = 48)	Reintervention = yes (n = 9)	OR	95% CI	p-value
Type of procedure					
Venography alone	24 (50.0%)	6 (66.7%)	Ref.	—	—
Venography + IVUS	24 (50.0%)	3 (33.3%)	0.50	0.11 – 2.23	0.364
Patient sex					
Female	45 (93.8%)	8 (88.9%)	Ref.	—	—
Male	3 (6.3%)	1 (11.1%)	1.88	0.17 – 20.36	0.605
Age at procedure (years)	42.4 (12.2) n=48	42.4 (17.0) n=9	1.00	0.95 – 1.06	0.984
Body mass index (kg/m²)	25.2 (4.7) n=48	25.7 (5.0) n=9	1.02	0.88 – 1.19	0.777
Number of pregnancies					
0	32 (71.1%)	5 (62.5%)	Ref.	—	—
1	4 (8.9%)	3 (37.5%)	4.80	0.82 – 28.15	0.082‡
≥ 2	9 (20.0%)	0 (0.0%)	N/A	N/A	N/A
Oral contraceptive or hormonal therapy					
No	31 (70.5%)	6 (85.7%)	Ref.	—	—
Yes	13 (29.5%)	1 (14.3%)	0.40	0.04 – 3.64	0.414
Prior documented DVT history					
No	25 (53.2%)	4 (44.4%)	Ref.	—	—
Yes	22 (46.8%)	5 (55.6%)	1.42	0.34 – 5.96	0.631
Presentation phenotype					
Chronic	39 (81.3%)	8 (88.9%)	Ref.	—	—
Acute	7 (14.6%)	1 (11.1%)	0.70	0.07 – 6.47	0.750
Mixed	2 (4.2%)	0 (0.0%)	N/A	N/A	N/A
Clinical CEAP classification	3.0 (3.0-3.0) n=48	3.0 (3.0-4.5) n=8	2.20	1.02 – 4.73	0.044*
Venous collaterals on imaging					
No	27 (58.7%)	6 (66.7%)	Ref.	—	—
Yes	19 (41.3%)	3 (33.3%)	0.71	0.16 – 3.20	0.656
Pain, tension, heaviness, or tingling					
Absent	16 (33.3%)	2 (22.2%)	Ref.	—	—
Present	32 (66.7%)	7 (77.8%)	1.75	0.33 – 9.41	0.514
Limb edema					
Absent	16 (33.3%)	2 (22.2%)	Ref.	—	—
Present	32 (66.7%)	7 (77.8%)	1.75	0.33 – 9.41	0.514
Venous claudication					
Absent	39 (81.3%)	7 (77.8%)	Ref.	—	—
Present	9 (18.8%)	2 (22.2%)	1.24	0.22 – 6.99	0.809
Pelvic symptoms or dyspareunia					
Absent	38 (79.2%)	9 (100.0%)	Ref.	—	—
Present	10 (20.8%)	0 (0.0%)	N/A	N/A	N/A
Varicose veins					
Absent	35 (72.9%)	8 (88.9%)	Ref.	—	—
Present	13 (27.1%)	1 (11.1%)	0.34	0.04 – 2.96	0.326
Number of stents placed					
1	35 (74.5%)	4 (44.4%)	Ref.	—	—
≥ 2	12 (25.5%)	5 (55.6%)	3.65	0.84 – 15.84	0.084‡
Proximal stent diameter (mm)					
14	7 (14.9%)	1 (12.5%)	Ref.	—	—
16	21 (44.7%)	6 (75.0%)	2.00	0.20 – 19.62	0.552
18	19 (40.4%)	1 (12.5%)	0.37	0.02 – 6.72	0.500
Proximal stent length (mm)					
80	9 (19.1%)	3 (33.3%)	Ref.	—	—
100	25 (53.2%)	1 (11.1%)	0.12	0.01 – 1.31	0.082‡
120	7 (14.9%)	3 (33.3%)	1.29	0.20 – 8.43	0.793
≥ 140	6 (12.8%)	2 (22.2%)	1.00	0.13 – 7.89	> 0.990
Post-procedure hospital stay (days)					
1	15 (31.9%)	3 (33.3%)	Ref.	—	—
≥ 2	32 (68.1%)	6 (66.7%)	0.94	0.21 – 4.27	0.933
Anticoagulant prescribed at discharge (1st phase)					
LMWH	17 (35.4%)	4 (44.4%)	Ref.	—	—
Rivaroxaban	25 (52.1%)	3 (33.3%)	0.51	0.10 – 2.57	0.415
Apixaban	6 (12.5%)	1 (11.1%)	0.71	0.07 – 7.66	0.776
VKA	0 (0.0%)	1 (11.1%)	N/A	N/A	N/A
Maintenance anticoagulant					
LMWH	11 (22.9%)	1 (11.1%)	Ref.	—	—
Rivaroxaban	27 (56.3%)	5 (55.6%)	2.04	0.21 – 19.49	0.537
Apixaban	10 (20.8%)	2 (22.2%)	2.20	0.17 – 28.14	0.544
VKA	0 (0.0%)	1 (11.1%)	N/A	N/A	N/A

Note. Values are presented as mean (SD) for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables, and n (%) for categorical variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated via binary logistic regression with reintervention (yes vs. no) as the outcome. Each variable was entered separately in unadjusted models. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical

analyses. N/A = not applicable (OR could not be computed due to zero observed events in one or both groups). IVUS = intravascular ultrasound; LMWH = low molecular weight heparin; VKA = vitamin K antagonist; CEAP = Clinical-Etiology-Anatomy-Pathophysiology; ‡ Approaches statistical significance ($p < 0.10$); * Statistically significant ($p < 0.05$), **$p<0.01$, ***$p<0.001$

Table V. *Multivariate associations with primary patency via logistic regression*

	Primary patency = no (n = 11)	Primary patency = yes (n = 48)	OR	95% CI	p-value
Clinical CEAP classification	3.0 (3.0-4.0) n=10	3.0 (3.0-3.0) n=48	0.50	0.23 – 1.07	0.074‡
Number of stents placed					
1	5 (45.5%)	36 (76.6%)	Ref.	—	—
≥2	6 (54.5%)	11 (23.4%)	0.30	0.07-1.32	0.113

Note. Values are presented as median (IQR) for non-normally distributed continuous variables and n (%) for categorical variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated via multivariate binary logistic regression with primary patency as the outcome. Variables with $p < .10$ in unadjusted analyses were entered into the multivariate model, except proximal stent length (mm) due to low sample size. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical analyses. N/A = not applicable (OR could not be computed due to zero observed events in one or more cells). CEAP = Clinical-Etiology-Anatomy-Pathophysiology. ‡ Approaches statistical significance ($p < 0.10$).

***Table VI**. Multivariate associations with loss of patency at follow up via Cox regression*

	Patency at follow up = no (n = 3)	Patency at follow up = yes (n = 52)	HR	95% CI	p-value
Age at procedure	59.7 (16.2) n=3	40.0 (11.6) n=52	**1.17**	**0.98 – 1.34**	**0.089**‡
Clinical CEAP classification	5.0 (3.0-6.0) n=3	3.0 (3.0-3.0) n=52	2.74	0.81 – 9.23	0.105

Note. Values are presented as mean (SD) for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables, and n (%) for categorical variables. Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated via multivariate Cox proportional hazards regression with loss of patency as the event of interest. Variables with $p < 0.10$ in unadjusted analyses were entered into the multivariate model. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical analyses. IVUS = intravascular ultrasound; CEAP = Clinical-Etiology-Anatomy-Pathophysiology. ‡ Approaches statistical significance ($p < 0.10$); * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table VII. *Kaplan Meier estimates for time to loss of patency at follow up compared by type of procedure*

	12 M	24 M	36 M	48 M	60 M	End of study	Log-rank test
Type of procedure							
Venography alone	100%	100%	100%	85.7%	76.2%	76.2% (74 M)	0.218
Venography + IVUS	100%	100%	100%	100%	100%	100% (57 M)	

Note. Values represent the cumulative probability of patency at each time point, calculated with Kaplan-Meier survival estimate, where the survival function reflects the probability of patency maintenance at time t. Higher values indicate a greater proportion of patients with confirmed patency by that time point. The End of study column reports this value at the time of the last observed event in each group, with the corresponding follow-up time in months indicated in parentheses. M = months.
‡ Approaches statistical significance ($p < 0.10$); * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

***Table VIII**. Multivariate associations with reintervention via logistic regression*

	Reintervention = no (n = 48)	Reintervention = yes (n = 9)	OR	95% CI	p-value
Number of pregnancies					
0	32 (71.1%)	5 (62.5%)	Ref.	—	—
1	4 (8.9%)	3 (37.5%)	4.97	0.76 – 32.56	0.095‡
≥ 2	9 (20.0%)	0 (0.0%)	N/A	N/A	N/A
Clinical CEAP classification	3.0 (3.0-3.0) n=48	3.0 (3.0-4.5) n=8	1.52	0.59 – 3.90	0.384
Number of stents placed					
1	35 (74.5%)	4 (44.4%)	Ref.	—	—
≥ 2	12 (25.5%)	5 (55.6%)	1.71	0.28 – 10.44	0.563

Note. Values are presented as median (IQR) for non-normally distributed continuous variables and n (%) for categorical variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated via multivariate binary logistic regression with reintervention as the outcome. Variables with $p < .10$ in unadjusted analyses were entered into the multivariate model, except proximal stent length (mm) due to low sample size. For categorical predictors, the reference category is indicated as Ref. Categories with missing data were excluded from statistical analyses. N/A = not applicable (OR could not be computed due to zero observed events in one or more cells). CEAP = Clinical-Etiology-Anatomy-Pathophysiology. ‡ Approaches statistical significance ($p < 0.10$).

Figures

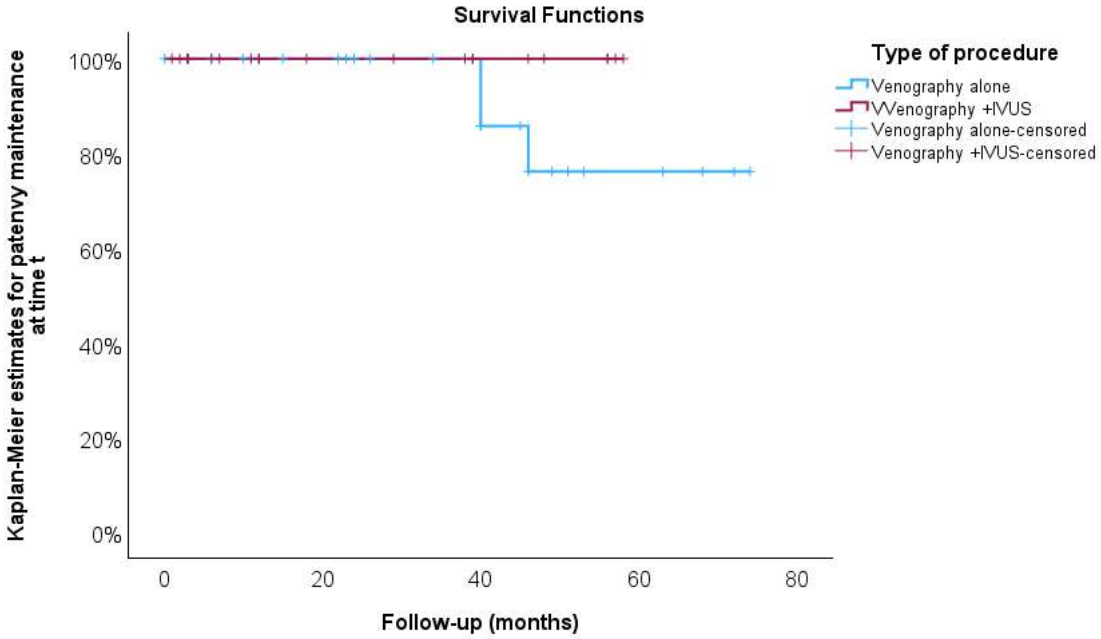


Figure 1. *Kaplan-Meier estimates for patency maintenance at follow up compared by type of procedure*

INSTITUTO DE **CIÊNCIAS BIOMÉDICAS ABEL SALAZAR**