Anatomical Classification of Chronic Venous Obstruction: Implications for Prognosis and Treatment

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Background: Chronic venous obstruction (CVO) of the iliofemoral tract is a significant cause of venous hypertension, leading to debilitating symptoms such as pain, swelling, and ulceration. Endovascular interventions, particularly venous stenting, have become the preferred treatment for CVO, but long-term stent patency remains variable, particularly in cases of extensive post-thrombotic disease.

Objective: This study proposed a novel anatomical classification system for iliofemoral CVO, categorizing patients based on the extent of venous involvement, and evaluates its prognostic value in predicting stent patency.

Materials and Methods: A retrospective multicenter study was conducted on 1,033 patients (1,207 limbs) who underwent venous stenting for symptomatic iliofemoral CVO between 2015 and 2019. The proposed classification system stratified CVO into five types based on anatomical involvement, ranging from non-thrombotic iliac vein lesions (Type 1) to extensive disease involving both the femoral and deep femoral veins (Type 5). Primary patency rates were analyzed using Kaplan-Meier survival curves, with multivariable Cox regression identifying independent predictors of patency loss.

Results: At 12 months, primary patency rates progressively declined with increasing classification severity (Types 1: 94.9%, 2: 90.3%, 3: 80.8%, 4: 60.6%, 5: 39.4%). Classification type and total stent count were identified as independent predictors of primary patency loss ($p < 0.001$ and $p = 0.002$, respectively). Patients with extensive disease (Types 4 and 5) demonstrated significantly lower patency rates and higher complication rates, emphasizing the need for adjunctive strategies to optimize outcomes.

Conclusion: The proposed classification system provides a structured approach for assessing disease severity in iliofemoral CVO, demonstrating significant prognostic value in predicting stent patency. By improving patient stratification and guiding treatment strategies, this system has the potential to enhance clinical decision-making and support future research efforts.

Keywords: chronic venous obstruction, iliofemoral veins, venous stenting, classification system, stent patency, venous hypertension

Introduction

Chronic venous obstruction (CVO) of the iliofemoral tract is a significant cause of venous hypertension, leading to debilitating symptoms such as pain, swelling, and ulceration. The condition arises from various etiologies, including post-thrombotic changes, congenital anomalies, and external compression, all of which can impair venous outflow and compromise patient quality of life (1-3). Endovascular interventions, particularly venous stenting, have emerged as a preferred treatment strategy, demonstrating high technical success and symptom relief (4-7). However, long-term stent patency remains highly variable, particularly in patients with extensive post-thrombotic disease (7-10).

Existing literature highlights that the extent of venous obstruction and the quality of inflow significantly impact stent durability (11-13). Despite these findings, a standardized classification system to stratify patients and predict outcomes has been lacking. This study proposes an anatomical classification system for iliofemoral CVO, categorizing patients based on the extent of venous involvement. By correlating classification types with stent patency, this system aimed to enhance prognostic accuracy, support clinical decision-making, and improve the comparability of future research.

This study introduces an anatomical CVO classification based on obstruction extent and evaluates its prognostic value for stent patency enabling clinicians to better predict intervention outcomes and refine patient selection criteria.

Materials and methods

This study utilized data from Jalaie et al. (2025) (14), titled *"Prognostic Value of a Classification System for Iliofemoral Stenting in Patients with Chronic Venous Obstruction"*, published in the *European Journal of Vascular and Endovascular Surgery* under a Creative Commons Attribution 4.0 International License (CC BY 4.0; https:// creativeco-mmons.org/ licenses/by/ 4.0/).

Study Design and Patient Selection

This retrospective multicenter study analyzed data from 1,033 patients with symptomatic iliofemoral CVO who underwent successful venous stenting at 13 specialized vascular centers. Patients were classified based on the anatomical extent of obstruction, excluding those with acute deep vein thrombosis (DVT) or a life expectancy of less than one year. Institutional review board approval was obtained at all participating centers, and patient data were anonymized.

Classification System

The proposed classification system stratifies CVO into five types:

Type 1: Non-thrombotic iliac vein lesion
Type 2: CVO confined to iliac segments
Type 3: CVO extending to the iliofemoral segment above the common femoral vein (CFV) confluence
Type 4: CVO involving either the femoral vein (Type 4a) or deep femoral vein (Type 4b)
Type 5: CVO involving both the femoral and deep femoral veins

A schematic representation of this classification system is included in Figure 1.

Procedural Details and Follow-Up

Venous stenting was performed using dedicated venous stents, with technical success defined as complete recanalization and stent deployment. In patients with extensive disease (Types 4 and 5), three treatment strategies were employed: (a) Stenting to the CFV without additional techniques (b) Stenting combined with endophlebectomy with or without arteriovenous fistula (AVF) creation (c) Stenting extending into one of the inflow veins (FV or DFV). Post-procedure management included 30–40 mmHg compression therapy and therapeutic anticoagulation for at least three months, with extended treatment based on individual risk factors.

Follow-up assessments involved duplex ultrasound (DUS) and clinical evaluations at regular intervals.

Outcome Measures and Statistical Analysis

Primary patency was defined as uninterrupted stent function without reintervention. Loss of patency was recorded when occlusion or >50% luminal obstruction occurred. Univariable and multivariable Cox regression models were used to identify predictors of primary patency loss, with Kaplan-Meier survival analysis estimating patency rates. Statistical significance was set at p-value<0.05.

Data Availability Statement

The data analyzed in this study were sourced from Jalaie et al. (2025) (14), available under a CC BY 4.0 license at https://doi.org/10.1016/ j.ejvs. 2024. 10. 002. Derived datasets generated during this study are.
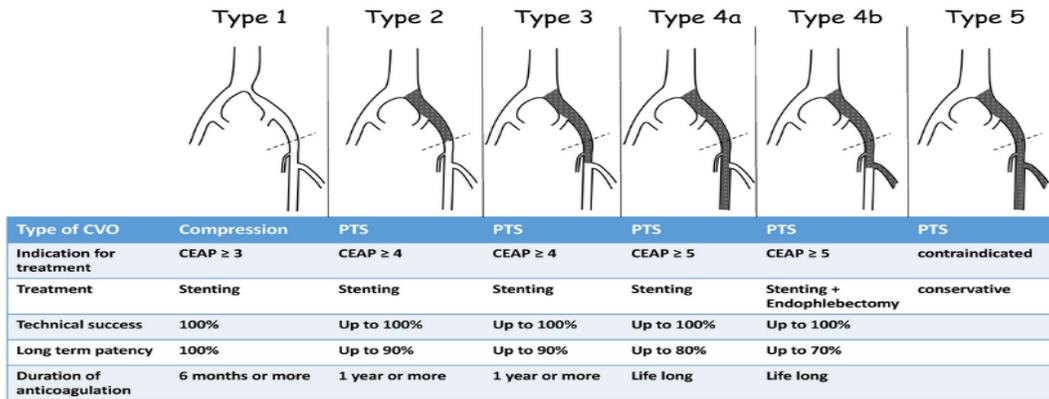
Classification of CVO

Fig 1. Schematic representation of the proposed anatomical classification system for chronic venous obstruction (CVO) of the iliofemoral tract. The classification includes five categories: Type 1 represents non-thrombotic iliac vein lesions; Type 2 involves CVO limited to iliac segments; Type 3 shows CVO of the iliofemoral segment above the common femoral vein (CFV) confluence; Type 4 demonstrates CVO of the iliofemoral segment extending into either the femoral vein (Type 4a) or deep femoral vein (Type 4b); and Type 5 indicates CVO of the iliofemoral segment affecting both main inflow veins (femoral and deep femoral veins).

Available from the corresponding author upon reasonable request

Results

Study Cohort

A total of 1,033 patients (1, 207 limbs) underwent venous stenting for symptomatic iliofemoral CVO. The mean age was 44.0 ± 14.7 years, and 59.5% of patients were females. The majority of cases involved the left limb (80.2%), with 15.8% of patients presented with inferior vena cava (IVC) involvement. A history of DVT was documented in 74.1% of cases **Table 1**.

Abbreviations: DVT – Deep Vein Thrombosis; IVC – Inferior Vena Cava.

adapted from Jalaie et al. (2025) [1], *European journal of vascular and endovascular surgery*, cc by 4.0 (https://creativecommons. org/licenses/by /4.0/). original data available at https://doi.org/10. 1016/ j.ejvs.2024. 10.002.

Primary Patency and Prognostic Impact of Classification

At 12 months, primary patency rates progressively declined with increasing classification severity (Types 1: 94.9%, 2: 90.3%, 3: 80.8%, 4: 60.6%, 5: 39.4%) (**Figure 2**).

Reproduced from Jalaie et al. (2025) (14), *European Journal of Vascular and Endovascular Surgery*, CC BY 4.0. Original data available at https://doi.org/10.1016/j.ejvs.2024.10.002.

Table 1. The data are presented as n (%) or mean ± standard deviation, unless specified otherwise.

| Characteristic	Details
Cohort size	1033 patients (1207 limbs analyzed)
Mean age	44.0 years (±14.7 SD)
Sex distribution	615 female (59.5%)
Body mass index (BMI)	26.9 kg/m² (±4.9 SD)
Laterality of involvement	
- Left-sided pathology	968 cases (80.2%)
- Right-sided pathology	239 cases (19.8%)
Comorbidities/Risk Factors	
- Prior DVT	765 patients (74.1%)
- Coagulopathy	213 patients (20.6%)
- Smoking history	314 patients (30.4%)
- IVC involvement	163 patients (15.8%)
Follow-up duration	Median 24 months
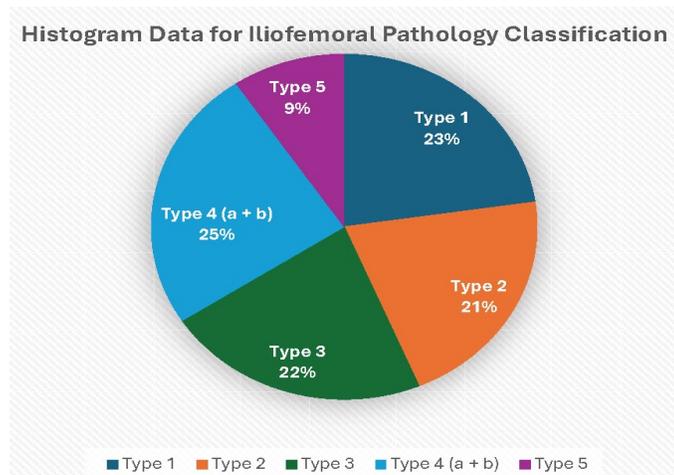
Fig. 2. Distribution of iliofemoral pathology subtypes (n=1,207 limbs): Type 1 (22.7%, 274 limbs), Type 2 (21.0%, 253 limbs), Type 3 (22.2%, 268 limbs), Type 4 (24.7%, 298 limbs; includes subtypes 4a/4b), and Type 5 (9.4%, 114 limbs).

Statistical analysis confirmed a significant correlation between classification type and patency rates (p p-value<0.001). Multivariable analysis identified classification type and the total number of stents used as independent predictors of primary patency loss (p-value<0.001 and p-value=0.002, respectively) (**Table 2**).

Significant predictors in adjusted models included total stent count (HR 1.23, p=0.002) and CVO severity (HR 2.33, p-value<0.001).
Adapted from Jalaie et al. (2025) [1], *European Journal of Vascular and Endovascular Surgery*, CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/). Original data available at https://doi.org/ 10. 1016/ j.ejvs. 2024.10.002.

Complications and Procedural Outcomes

Minor bleeding was reported in 4.7% cases, with major bleeding occurring in 2.0%, primarily in patients requiring hybrid procedures. Surgical complications, including wound infections and lymphorrhea, were observed in 16% of patients undergoing endophlebectomy.

Contralateral DVT was identified in 0.7% of cases, predominantly in patients with non-thrombotic iliac vein lesions.

Follow-Up and Assisted Patency

Median follow-up was 23 months, with assisted primary and secondary patency rates following similar trends as primary patency. Patients with more extensive disease (Types 4 and 5) demonstrated lower long-term patency, reinforcingthe prognostic implications of the classification system (**Figure 3**). Reproduced from Jalaie et al. (2025) (14), *European Journal of Vascular and Endovascular Surgery*, CC BY 4.0. Original data available at https://doi.org/10.1016/j.ejvs.2024.10.002.

Table 2. univariate and multivariate cox regression analysis of factors associated with primary patency loss in chronic venous obstruction.

Variables	Univariate Analysis			Multivariate Analysis		
	HR	95% CI	P-value	HR	95% CI	P-value
Total stent count	1.3	1.19–1.42	<0.0	1.23	1.08–1.39	0.0
BMI	0.99	0.96–1.01	0.31	—	—	—
CVO severity	2.21	1.99–2.46	<0.0	2.33	2.0–2.72	<0.0
Sex (female vs. male)	0.8	0.63–1.01	0.06	0.79	0.57–1.09	0.15
Smoking history	0.82	0.53–1.27	0.38	—	—	—
Prior DVT	1.51	1.5–2.16	0.03	1.27	0.86–1.9	0.23
Coagulopathy	1.21	0.91–1.6	0.19	—	—	—
Age	0.99	0.99–1.0	0.18	—	—	—
IVC involvement	1.43	0.97–2.11	0.07	0.76	0.45–1.29	0.31

Significant predictors in adjusted models included total stent count (hr 1.23, p-value=0.002) and CVO severity (hr 2.33, p-value<0.001).
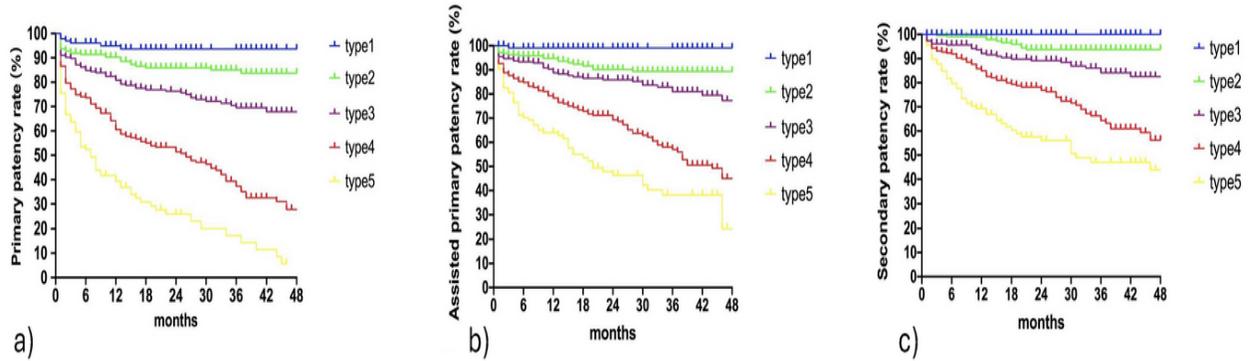
Fig. 3. Kaplan-Meier curves illustrating (a) primary, (b) assisted primary, and (c) secondary patency rates stratified by iliofemoral pathology subtype (Types 1–5) in patients with chronic venous obstruction. At 12 months, primary patients declined with increasing disease severity: 94.9% (Type 1), 90.3% (Type 2), 80.8% (Type 3), 60.6% (Type 4), and 39.4% (Type 5). All patency outcomes were significantly associated with CVO extent ($p<0.05$ for pairwise comparisons between consecutive subtypes).

Discussion

This study introduces an anatomical classification system for iliofemoral CVO and demonstrates its prognostic value in predicting stent patency. The findings indicate a clear correlation between classification type and long-term outcomes, providing a structured approach for assessing disease severity and guiding treatment decisions. Given the increasing adoption of venous stenting as the preferred intervention for iliofemoral obstruction, a standardized classification system is essential for improving patient selection, optimizing procedural planning, and enhancing post-intervention management.

Clinical Implications of the Classification System

The proposed classification stratifies CVO into five distinct types based on anatomical involvement, facilitating a systematic approach to disease assessment. The observed decline in primary patency rates with increasing classification severity highlights the pivotal role of venous inflow in determining long-term stent function. Patients with Types 1 and 2 diseases, characterized by limited iliac vein involvement, demonstrated superior patency rates, likely due to preserved venous inflow. In contrast, those with Types 4 and 5 disease, where obstruction extends to the femoral and deep femoral veins, experienced significantly lower patency, emphasizing the challenges associated with extensive post-thrombotic disease (15, 16).

These findings align with previous research demonstrating that inflow quality strongly influences stent durability (4, 17-19).

By categorizing patients based on anatomical extent, this classification system not only aids in prognostication but also facilitates more accurate comparisons across future studies. Additionally, it provides valuable information for patient counseling, allowing clinicians to set realistic expectations regarding treatment outcomes and the likelihood of requiring secondary interventions.

Challenges in Extensive Disease (Types 4 and 5)

Patients with advanced post-thrombotic disease (Types 4 and 5) face greater treatment challenges due to severely compromised venous inflow (5, 20, 21). The significantly lower patency rates observed in these groups suggest that stenting alone may be insufficient, necessitating adjunctive strategies such as endophlebectomy or arteriovenous fistula (AVF) creation to enhance inflow. However, these hybrid procedures are associated with increased procedural complexity and higher complication rates, as observed in this study. Notably, surgical complications such as wound infections and lymphorrhea were more frequent in patients undergoing endophlebectomy, raising concerns about the risk-benefit balance of these interventions (22-24).

Given the suboptimal outcomes in these patients, future research should focus on refining treatment strategies to improve patency rates. Advanced imaging techniques, including intravascular ultrasound (IVUS) and computational flow modeling, may provide additional insights into venous hemodynamics, aiding in the selection of optimal stenting strategies for patients with complex diseases. Furthermore, long-term follow-up studies are needed to evaluate whether

specific inflow-preserving techniques can enhance durability in patients with extensive obstruction.

Future Directions

While this study provides a foundational framework for classifying iliofemoral CVO, further prospective validation is necessary to confirm its clinical utility. A key area for future research is the integration of hemodynamic parameters into the classification model, as flow dynamics play a crucial role in stent patency. Additionally, the development of standardized treatment algorithms based on classification type could enhance procedural decisionmaking and improve long-term outcomes.

Another important consideration is the potential role of novel therapeutic strategies in optimizing venous reconstruction. Emerging techniques, such as bioengineered venous grafts and pharmacomechanical thrombolysis, may offer alternative solutions for patients with severe post-thrombotic disease. As endovascular technology continues to evolve, incorporating these advancements into treatment protocols will be essential for improving patient outcomes.

Conclusion

The proposed anatomical classification system for iliofemoral CVO provides a valuable tool for predicting stent patency and guiding clinical decision-making. By offering a structured approach to assessing disease severity, this system enhances prognostic accuracy, facilitates more meaningful comparisons in research, and supports individualized treatment planning. Future studies should focus on refining treatment algorithms based on classification type and exploring novel strategies to optimize outcomes for patients with extensive venous obstruction.

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