

Optimizing Venous Stenting: Consensus Recommendations for Enhanced Management of Lower Extremity Deep Vein Thrombosis

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Abstract

Introduction Deep vein thrombosis (DVT) poses a complex challenge and often leads to postthrombotic syndrome (PTS), a debilitating complication. The emergence of venous stents offers a potential preventive avenue against this complication. This study aimed to provide consensus recommendations on the use of venous stent for DVT.

Materials and Methods From June to July 2023, 20 internal medicine, angiology and vascular surgery, and vascular and interventional radiology experts were involved in the Delphi process. Thirty-one recommendations, categorized into three thematic areas, were rigorously evaluated: indications for stent use, stent selection and placement, and monitoring and prevention of complications. Agreement was evaluated using a Likert scale, with consensus defined as agreement by two-thirds of the participants.

Results Consensus was reached for 23 (74.2%) of 31 recommendations. The agreement was centered on considerations, such as stent placement in specific acute DVT scenarios, emphasizing pivotal stent characteristics. However, there were divergences in the recommended stent length to prevent migration and stent characteristics based on ilio caval bifurcation morphology. Notably, there was no consensus on whether patients with DVT caused by a major transient risk factor need more than 3 months of anticoagulation therapy or whether aspirin should be added to anticoagulant treatment after venous stenting.

Keywords

- ▶ deep vein thrombosis
- ▶ postthrombotic syndrome
- ▶ endovascular interventions
- ▶ venous stent
- ▶ stenting
- ▶ consensus

Conclusions These consensus recommendations offer practical insights into optimizing venous stent use to prevent PTS in DVT patients. Addressing the critical aspects of stent selection, placement, and postprocedural care, these recommendations contribute to clinical decision-making. The identified divergences underscore the importance of consensus and thus indicate the need for further investigation.

Venous thrombosis is estimated to affect 1 in 1,000 people annually, with two-thirds presenting with deep vein thrombosis (DVT) and one-third presenting with pulmonary embolism.¹ In addition to diminished quality of life, which can be comparable to that of other chronic diseases in the short term,² DVT is associated with important complications, including pulmonary embolism and postthrombotic syndrome (PTS). PTS occurs in 20 to 50% of patients with DVT despite anticoagulant treatment and is severe in 5 to 10% of patients.^{3–5} Moreover, DVT has a high recurrence rate, with a 5-year cumulative incidence of recurrent DVT of 21.5% after the first DVT and 27.9% after the second DVT.⁶ It is associated with a 1-year all-cause mortality rate of 4.6 (3.8–5.7) and 8.0 (7.1–9.0) person-years for isolated distal DVT and proximal DVT, respectively.⁷

Strategies for managing DVT, including nonpharmacological and pharmacological strategies, are well delineated in the current clinical practice guidelines.^{8–10} However, there are no well-established effective treatments for PTS. While elastic compression stockings and lifestyle measures such as elevating the legs, losing weight, and exercising may offer some relief, endovascular interventions are selectively employed due to limited available evidence.¹¹ It is crucial to emphasize that the cornerstone of PTS management lies in prevention.^{5,11}

Technical improvements in endovascular interventions have led to the increasing use of venous stenting for the management of venous obstruction in patients with acute or chronic DVT symptoms. In many cases, venous stenting serves as an adjunct treatment alongside other endovascular interventions, such as catheter-directed thrombolysis.^{12,13} This intervention has also evolved with increasing clinical experience, improvements in venous imaging, and the approval of dedicated venous stents for iliac vein use by some regulatory authorities.¹⁴ However, evidence supporting this procedure is scarce.^{12,13}

Only a few randomized clinical trials have assessed the efficacy of venous stenting for DVT management.^{15–17} Information on the use of venous stenting and its complications in patients with acute or chronic DVT is largely based on observational studies, primarily consisting of case series and retrospective studies, as shown in recent systematic reviews.^{18–25}

In this context, a panel of experts from the Spanish Society of Internal Medicine, Spanish Society of Vascular and Interventional Radiology, and Spanish Society of Angiology and Vascular Surgery was assembled by the collaborating societies. We aimed to evaluate the available evidence and formulate specific recommendations regarding the indications, placement, follow-up, and prevention of complications associated with the use of venous stents for the management of DVT of the lower extremity.

Materials and methods

Development of the Questionnaire and Expert Selection

The project coordinator (J.T.S.) selected a group of six experts (two from each participating society) to assemble a scientific committee. Subsequently, the scientific committee identified and invited from the three participating societies 22 individuals with at least 5 years of experience in assessing the indications and/or managing and placing venous stents to participate in the Delphi consensus.

During a meeting held on April 13, 2023, the Scientific Committee, drawing upon their knowledge, clinical experience, and comprehensive review of the evidence, formulated a document containing 31 recommendations on the use of stents for the management of DVT. These recommendations were grouped into three overarching thematic areas: (1) indications for the use of venous stents, which, in turn, addressed patient profiles for whom the use of a stent is recommended (4 recommendations) and situations where stent usage should be avoided (3 recommendations); (2) stent selection and placement, which explored factors influencing stent selection (10 recommendations), necessary evaluations before stent insertion (1 recommendation), and considerations for stent deployment (3 recommendations); and (3) complication monitoring and prevention, with a focus on strategies to manage the conditions of patients after stent placement (10 recommendations).

The Delphi method

The Delphi method is a frequently used system for collecting opinions on a specific issue in a structured manner from a group of experts.²⁶ It is used when evidence on that specific topic is very limited, and it has been applied to different health care contexts, including technology assessment and clinical practice development.²⁶ The key features of this method are the anonymous nature of the survey and the fact that participants receive feedback on their responses and can adjust their initial responses according to the feedback through an iterative process.^{26,27}

The participants were provided with a Microsoft Forms web link to complete the questionnaire. The participants scored each recommendation using a 9-point Likert scale, with 1 indicating strongly disagree and 9 indicating strongly agree. Additionally, participants had the option of including comments for each recommendation in a free-text field.

Two rounds of the Delphi method were completed. The questionnaire was administered in the first round. Recommendations lacking a consensus were discussed by the scientific committee. Based on this discussion, the recommendations

with or without modifications (see below) proceeded to the second round of the Delphi. In the second round, participants received feedback on the overall results of the first round along with information about the individual responses.

Statistical Analysis

The responses on the Likert scale were categorized into three groups: disagree (scores 1–3), neither agree nor disagree (scores 4–6), and agree (scores 7–9). For each recommendation, the absolute and relative frequencies were calculated for each Likert scale score. The median was also estimated as an indicator of the strength of the agreement, identifying the triad of responses within which the median fell. Consensus was determined to be achieved if two-thirds of the responses (66.6%) were within the triad.

The results are presented in summary tables with information on the round in which consensus was reached, the number

of experts who responded to that recommendation in the respective round, the relative frequency of responses across the 9 points of the Likert scale, the proportion of consensuses reached, and the median (► **Tables 1–3**). Recommendations with consensuses are highlighted by shading the triad of responses, in which the consensus is situated in gray.

Statistical analyses were performed using the IBM SPSS software package (IBM Corp. Released 2011, IBM SPSS Statistics for Windows, Version 20.0, Armonk, New York: IBM Corp.).

Results

Overall Results

Finally, 20 of the 22 selected experts agreed to participate, with 8 specializing in internal medicine, 8 specializing in angiology and vascular surgery and 4 specializing in vascular and interventional radiology. Ten of the 20 experts that

Table 1 Indications for the use of venous stents

Question/Issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
In which patients with DVT is the use of stent indicated?														
1. Stenting can be considered in patients with acute symptomatic DVT of compressive cause with involvement of at least the iliac vein, who present severe symptoms and good previous functional status, and in those with persistent severe symptoms despite initial anticoagulation treatment, after thrombolysis (mechanical or pharmaco-mechanical).	1	20	0	0	0	0	0	0	5	30	60	9	95	Yes
2. Stenting can be considered in patients with acute symptomatic DVT of non-compressive cause with involvement of at least the iliac vein, who present severe symptoms and good previous functional status after thrombolysis (mechanical or pharmaco-mechanical), and in those with persistent severe symptoms despite initial anticoagulant therapy.	2	20	5	0	10	0	15	5	10	40	15	8	65	No
3. Stenting can be considered in patients with chronic DVT (i.e., residual thrombosis after more than 6 months of adequate anticoagulation therapy) of compressive cause (e.g., May-Thurner syndrome) with involvement of at least the iliac vein, and who present a moderate-severe postthrombotic syndrome that causes significant limitations in the patient’s daily life.	1	20	0	0	0	0	0	5	10	25	60	9	95	Yes
4. Stenting can be considered in patients with chronic DVT (i.e., residual thrombosis after more than 6 months of adequate anticoagulation therapy) of noncompressive cause with involvement of at least the iliac vein, and who present a moderate-severe postthrombotic syndrome that causes significant limitations in the patient’s daily life.	1	20	0	10	0	10	0	0	25	10	45	8	80	Yes

(Continued)

Table 1 (Continued)

Question/Issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
In which situations should the use of stents be avoided?														
5. Stenting should be avoided in patients with acute or chronic DVT if there is only isolated involvement of the femoral, popliteal, and/or calf veins.	1	20	0	0	0	0	0	5	5	25	65	9	95	Yes
6. Stenting should be avoided in patients with acute or chronic DVT if the patient has an active infectious disease.	1	20	0	0	0	0	0	5	5	30	60	9	95	Yes
7. Stenting should be avoided in children with DVT.	2	20	0	0	0	0	10	0	15	35	40	8	90	Yes

Note: Values in %C are in bold when there was agreement.

Abbreviations: DVT, deep vein thrombosis; % C, proportion of consensus; Agree, agreement; M, median; N, number of respondents.

Table 2 Stent selection and placement

Question/Issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
What factors should be taken into account in the stent selection?														
8. To determine which stent is to be used, an intravascular ultrasound study is a very useful support tool to know the stent caliber, length, position and for intraoperative quality control of how the implant has been performed.	1	20	0	0	0	5	5	5	15	15	55	9	85	Yes
9. The stent selected should have high flexibility, radial strength, and high compression resistance.	1	20	0	0	0	0	0	0	15	15	70	9	100	Yes
10. The vein diameter should be oversized by at least 20%.	1	20	0	5	0	0	15	0	25	15	40	8	80	Yes
11. The standard diameter for the iliac axis is 14–16 mm.	1	20	0	0	0	0	10	5	10	20	55	9	85	Yes
12. For the iliofemoral axis, the standard diameter is 12–14 mm.	1	20	0	5	0	0	15	5	10	10	55	9	75	Yes
13. The length of the stent should not be less than 80 mm, to avoid migration.	2	20	0	0	5	0	30	5	5	25	30	8	60	No
14. The stent should be easily and accurately released to avoid migration.	1	20	0	0	0	5	5	5	10	15	60	9	85	Yes
15. If the ilio caval bifurcation has a vertical morphology, a stent with an oblique design at the proximal end could be considered to avoid covering the ostium of the contralateral iliac vein with the stent.	2	20	0	5	0	0	30	0	10	15	40	8	65	No
16. If the ilio caval bifurcation has a more horizontal morphology, a straight stent is preferable to avoid contact with the contralateral iliac vein.	2	20	0	5	0	0	30	0	20	20	25	7	65	No
17. It is recommended that the stent allow good visibility to improve precision during implantation.	1	20	0	0	0	0	5	5	5	20	65	9	90	Yes
What evaluations are necessary prior to the placement of a stent?														
18. In addition to Echo-Doppler and the usual preoperative evaluations, an axial imaging test with contrast (CT, CT phlebography, MRI, or venography) should be used in the assessment prior to venous stenting, to visualize the iliofemoral venous axis.	1	20	0	0	0	0	0	0	5	20	75	9	100	Yes

Table 2 (Continued)

Question/Issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
What factors should be taken into account for stent placement?														
19. When crossing under the inguinal ligament, it is advised to avoid overlapping two stents at that level and to have only one stent make contact with it.	2	20	0	0	0	5	25	0	10	25	35	8	70	Yes
20. Interfering with the ilio caval confluence in the flow of the contralateral iliac vein should be avoided.	1	20	0	0	5	0	20	0	0	30	45	8	75	Yes
21. If there is severe involvement of the common femoral vein involving the ostium of the deep femoral vein and its branches, endophlebectomy and the association of a temporary arteriovenous fistula could be considered.	2	20	0	0	5	5	35	0	10	15	30	7	55	No

Note: Values in %C are in bold when there was agreement.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; % C, proportion of consensus; Agree, agreement; M, median; N, number of respondents.

Table 3 Monitoring and prevention of complications

Question/issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
What treatment is recommended after stent placement?														
22. Adequate anticoagulation should be ensured early or immediately after stent implantation to avoid early stent thrombosis.	1	20	5	0	0	0	0	0	0	15	80	9	95	Yes
23. Initial anticoagulation should be performed with low-molecular-weight heparin (weight adjusted).	1	20	5	0	0	0	15	5	15	20	40	8	75	Yes
24. Long-term anticoagulation (at least the first 6 months) is recommended if the bleeding risk is low–moderate and the DVT was idiopathic or caused by a minor transient risk factor (e.g., hormone therapy, immobilization of less than 3 days).	2	20	5	0	5	0	5	5	15	30	35	8	80	Yes
25. Before hospital discharge, it is recommended to perform an Echo-Doppler (ultra-early follow-up in the first 2–3 days).	1	20	0	0	5	0	15	0	20	0	60	9	80	Yes
26. Long-term anticoagulation (beyond the first 3 months) is suggested if the bleeding risk is low–moderate and the DVT was caused by a major transient risk factor (for example, orthopedic surgery, immobilization of more than 3 days).	2	20	15	0	10	0	10	0	30	15	20	7	65	No
27. After venous stenting, it is recommended that antiplatelet therapy be added to anticoagulation during the first month.	2	20	25	10	15	5	5	5	20	10	5	3,5	35	No
28. After venous stenting, it is recommended that antiplatelet therapy be added to anticoagulation during the first 6–12 months.	2	20	30	10	15	0	5	5	20	15	0	3	35	No

(Continued)

Table 3 (Continued)

Question/issue	Round	N	Likert-scale score									M	% C	Agree
			1	2	3	4	5	6	7	8	9			
29. If anticoagulant therapy is discontinued, antiplatelet therapy is recommended.	2	20	5	5	5	0	10	0	20	15	40	8	75	Yes
30. Close follow-up should be performed during the first month after stent placement, and thereafter a follow-up by a specialist in the pathology should be established with the frequency established in the center for these patients.	1	20	0	0	0	0	0	0	20	15	65	9	100	Yes
31. In the case of in-stent thrombosis, mechanical or pharmacomechanical thrombolysis can be considered.	1	20	0	0	0	0	5	0	10	20	65	9	95	Yes

Note: Values in %C are in bold when there was agreement.

Abbreviations: DVT, deep vein thrombosis; % C, proportion of consensus; M, median; N, number of respondents.

agreed to participate had more than 15 years of experience, 6 had 10 to 15 years of experience and 4 had 5 to 10 years of experience.

The first round of the Delphi method was conducted in June 2023, during which all 20 selected experts provided responses. Overall, a consensus was reached on 19 (61.3%) of the 31 recommendations. Among the 12 recommendations lacking consensus (→ **Supplementary Table S1**, available in the online version only), 2 originated from the section on indications for the use of venous stents (2 of 7), 5 from the stent selection and placement section (5 of 14), and 5 from the monitoring and prevention of complications section (5 of 10). The Scientific Committee convened to scrutinize these items and modified the wording of six of them (→ **Supplementary Table S1**).

Subsequently, these 12 recommendations were included in the second round of the Delphi in July 2023, with responses from the same 20 selected experts. Among the 12 recommendations evaluated in this round, a consensus was reached on four (→ **Tables 1–3**). Overall, a consensus was thus reached for 23 of the 31 recommendations (74.2%) (→ **Table 4**). The combined results of the two rounds are presented below.

Indications for the Use of Venous Stents

After these two rounds, consensus was achieved on six of the seven recommendations in this section (→ **Table 1**). It was collectively agreed that the use of stents can be considered for patients with acute DVT caused by compression involving at least the iliac vein, and who present with severe symptoms and exhibit a favorable prior functional state. Additionally, a consensus was reached for patients with persistent severe symptoms despite initial anticoagulation treatment following thrombolysis (mechanical or pharmacomechanical) (median: 9). Furthermore, consensus extended to use of stents in individuals with chronic DVT of both compressive (median: 9) and noncompressive causes (median: 8), with iliac involvement and experiencing moderate to severe PTS with significant impact on patients' quality of life. However, there was no consensus regarding the use of stents in patients with acute DVT of noncompressive causes. Although

proximity to agreement was observed (median: 8), a predefined level of consensus was not reached, with 65% agreement and three experts disagreeing.

There was a consensus that stent placement should be avoided in patients with acute or chronic DVT exhibiting isolated involvement of the femoral, popliteal, or calf muscle veins (median: 9) or in the presence of an active infectious disease (median: 9). Furthermore, a consensus was reached among experts that stent placement should be avoided in children (median: 8).

Stent Selection and Placement

Among the 14 recommendations in this section, consensus was reached on 10 (→ **Table 2**).

Experts considered an intravascular ultrasound (IVUS) study to be very useful in determining the necessary stent characteristics, such as caliber and length, positioning, and intraoperative control of the implant (median: 9). A consensus was established for various stent attributes, including great flexibility, radial strength, and high resistance (median: 9); a diameter at least 20% greater than that of the vein (median: 8); a standard recommended diameter of 14 to 16 mm for the iliac axis (median: 9); and a standard diameter of 12 to 14 mm for the iliofemoral axis (median: 9). Additionally, there was consensus that the stent should allow good visibility to enhance precision during implantation (median: 9) and should facilitate easy and precise release to prevent migration (median: 9). However, there was no consensus on the notion that to prevent migration, an implant should be at least 80 mm long (median: 8). In this regard, 35% of the experts were indifferent, although they leaned toward agreement. There was also no consensus on stent characteristics based on whether the ilio caval bifurcation exhibited a vertical morphology (median: 8) or a more horizontal morphology (median: 7); nevertheless, 65% agreed with both statements.

Experts unanimously agreed that for the evaluation preceding venous stent placement, in addition to Doppler ultrasound, an axial imaging test with contrast agent (such as

Table 4 Consensus recommendations for the use of venous stenting in the management of deep venous thrombosis of the lower extremity

Indications for the use of stents
<ul style="list-style-type: none"> Stenting can be considered in patients with acute symptomatic DVT of compressive cause with involvement of at least the iliac vein, who present severe symptoms and good previous functional status, and in those with persistent severe symptoms despite initial anticoagulation treatment, after thrombolysis (mechanical or pharmaco-mechanical).
<ul style="list-style-type: none"> Stenting can be considered in patients with chronic DVT (i.e., residual thrombosis after more than 6 months of adequate anticoagulation therapy) of compressive cause (e.g., May–Thurner syndrome) with involvement of at least the iliac vein, and who present a moderate–severe postthrombotic syndrome that causes significant limitations in the patient’s daily life.
<ul style="list-style-type: none"> Stenting can be considered in patients with chronic DVT (i.e., residual thrombosis after more than 6 months of adequate anticoagulation therapy) of noncompressive cause with involvement of at least the iliac vein, and who present a moderate–severe postthrombotic syndrome that causes significant limitations in the patient’s daily life.
<ul style="list-style-type: none"> Stenting should be avoided in patients with acute or chronic DVT if there is only isolated involvement of the femoral, popliteal, and/or calf veins.
<ul style="list-style-type: none"> Stenting should be avoided in patients with acute or chronic DVT if the patient has an active infectious disease.
<ul style="list-style-type: none"> Stenting should be avoided in children with DVT.
Stent selection and placement
<ul style="list-style-type: none"> To determine which stent is to be used, an intravascular ultrasound study is a very useful support tool to know the stent caliber, length, position, and for intraoperative quality control of how the implant has been performed.
<ul style="list-style-type: none"> The stent selected should have high flexibility, radial strength, and high compression resistance.
<ul style="list-style-type: none"> The vein diameter should be oversized by at least 20%.
<ul style="list-style-type: none"> The standard diameter for the iliac axis is 14–16 mm.
<ul style="list-style-type: none"> For the iliofemoral axis the standard diameter is 12–14 mm.
<ul style="list-style-type: none"> The stent should be easily and accurately released to avoid migration.
<ul style="list-style-type: none"> It is recommended that the stent allow good visibility to improve precision during implantation.
<ul style="list-style-type: none"> In addition to Echo-Doppler and the usual preoperative evaluations, an axial imaging test with contrast (CT, CT phlebography, MRI or venography) should be used in the assessment prior to venous stenting, to visualize the iliofemoral venous axis.
<ul style="list-style-type: none"> When crossing under the inguinal ligament, it is advised to avoid overlapping two stents at that level and to have only one stent make contact with it.
<ul style="list-style-type: none"> Interfering with the ilio caval confluence in the flow of the contralateral iliac vein should be avoided.
Monitoring and prevention of complications
<ul style="list-style-type: none"> Adequate anticoagulation should be ensured early or immediately after stent implantation to avoid early stent thrombosis.
<ul style="list-style-type: none"> Initial anticoagulation should be performed with low-molecular-weight heparin (weight adjusted).
<ul style="list-style-type: none"> Long-term anticoagulation (at least the first 6 months) is recommended if the bleeding risk is low–moderate and the DVT was idiopathic or caused by a minor transient risk factor (e.g., hormone therapy, immobilization of less than 3 days).
<ul style="list-style-type: none"> Before hospital discharge, it is recommended to perform an Echo-Doppler (ultra-early follow-up in the first 2–3 days).
<ul style="list-style-type: none"> If anticoagulant therapy is discontinued, antiplatelet therapy is recommended.
<ul style="list-style-type: none"> Close follow-up should be performed during the first month after stent placement, and thereafter a follow-up by a specialist in the pathology should be established with the frequency established in the center for these patients.
<ul style="list-style-type: none"> In the case of in-stent thrombosis, mechanical or pharmacomechanical thrombolysis can be considered.

Abbreviations: CT, computed tomography; DVT, deep vein thrombosis; MRI, magnetic resonance imaging.

computed tomography [CT], CT phlebography, magnetic resonance imaging [MRI], or venography) should be recommended for visualizing the iliofemoral venous axis (median: 9).

Regarding stent placement, a consensus emerged that when the inguinal ligament is crossed, it is recommended that two stents do not overlap at that level and that only a single stent should make contact with it (median: 8). Furthermore, interference at the ilio caval confluence in contralateral iliac flow should be avoided (median: 8). However, there was no consensus on the consideration of endophlebectomy and its

association with a temporal arteriovenous fistula if severe involvement of the common femoral vein encompassing the ostia of the deep femoral vein and its branches is present (median: 7). In this particular recommendation, seven respondents positioned themselves at the midpoint of the scale, indicating a neutral stance.

Monitoring and Prevention of Complications

Among the 10 recommendations in this section, a consensus was reached for 7 (► **Table 3**).

Concerning anticoagulation therapy, there was a consensus that it should be started early or immediately after stent implantation (median: 9). The consensus further extended to the preference for initial treatment with low-molecular-weight heparin (median: 8). Prolonged anticoagulation was recommended for at least the first 6 months, especially if the bleeding risk was low or moderate and if the DVT was either idiopathic or provoked by a minor transient risk factor (median: 8). However, there was no consensus on anticoagulation therapy maintenance beyond the first 3 months despite the low to moderate bleeding risk in patients with DVT related to a major transient risk factor (for example, orthopedic surgery) (median: 7; 65% consensus). Additionally, Echo-Doppler imaging was recommended as an “ultra-early” follow-up assessment in the first 2 to 3 days and before discharge (median: 9).

There was no consensus on adding antiplatelet treatment to anticoagulation therapy either during the first month (median: 3.5) or during the first 6- to 12 months (median: 3) after venous stenting. As indicated by the medians, a significant percentage (50–55%) expressed disagreement with these statements. However, there was agreement to recommend antiplatelet treatment in the event of discontinuation of anticoagulant treatment (median: 8).

Close follow-up was advised during the first month after stent insertion, followed by subsequent specialist follow-ups at a frequency established by the center (median: 9). Finally, in the event of in-stent thrombosis, the experts agreed to consider mechanical or pharmacochemical thrombolysis (median: 9).

Discussion

The aim of this consensus was to provide some recommendations regarding key aspects of venous stent utilization for lower extremity DVT management, and we achieved a 75% consensus rate among experts. Limited evidence on stent usage contributes to the challenge of consensus building, aligning with the scarcity of specific recommendations in clinical practice guidelines, except those from the Society of Interventional Radiology.^{14,28}

In acute DVT with iliac vein compression, severe symptoms, and a preserved functional state, the experts recommended to consider stenting. Similar to the Society of Interventional Radiology guidelines, they suggested stent placement after thrombolysis, emphasizing the need for patient discussion regarding long-term risks.²⁸ Conversely, some guidelines prioritize anticoagulation therapy over intervention for acute thrombosis.⁸

For chronic DVT with iliac vein involvement and moderate-to-severe PTS, our experts aligned with the European Society of Cardiology recommendations.²⁹ The consensus rejected stent placement for isolated femoral, popliteal, or calf vein involvement, aligning with the European Society of Vascular Surgery and Society of Interventional Radiology guidelines.^{28,30} The unanimous agreement against stent placement in children mirrored the existing recommendations.²⁸ The importance of IVUS for stent assessment reached

a consensus. Some guidelines recommend the use of IVUS along with venography in most patients to improve vein assessment after thrombus removal, but this recommendation is weak.^{28,31}

The experts reached a consensus on the key characteristics of an ideal stent, including flexibility, radial strength, and high compression resistance. Stent requirements vary based on location, with a special emphasis on compression resistance when crossing the inguinal ligament.^{31,32} The diameter consensus includes a size at least 20% larger than the vein, with standards of 14 to 16 mm for the iliac axis and 12 to 14 mm for the iliofemoral axis. Preventing migration is crucial, with an agreement on easy and precise release; however, no consensus has been reached on a minimum length of 80 mm. Other guidelines only make broad recommendations, such as ensuring that the stent has the optimal diameter and length to facilitate long-lasting patency, prevent pain, and avoid migration.^{14,28} According to recent reviews, an ideal stent should exhibit characteristics such as high radial strength, flexibility, appropriate size, fixation to prevent migration, conformity to the vein, clear visibility, nonthrombogenicity, biostability, resistance to infection, durability, and cost-effectiveness.³²

The experts agreed that an imaging test with contrast agent (CT, CT phlebography, MRI, or venography) should be recommended for evaluation prior to the placement of a venous stent. Some guidelines consider performing CT phlebography, MRI, or venography when Doppler ultrasonography is inconclusive or not feasible.³⁰ Other authors believe that these tests are useful for determining the extent of the disease and excluding extravascular causes responsible for the obstruction, such as tumors or retroperitoneal fibrosis.³²

Regarding stent placement, there was consensus that when the inguinal ligament is crossed, it is recommended that two stents do not overlap at that level and that only one stent contacts it. Based on experience with arterial stents, stent placement across joints has traditionally not been advised because of the risk of focal hyperplasia, stent compression or fracture, and long-term patency problems.³² The results of a recent systematic review on venous stents extending across the inguinal ligament showed mixed results that, according to the authors, do not allow recommendations to be made for or against.³³ The recommendation of this consensus is based on the experience of the scientific committee.

There was also consensus that interference with the iliocaval confluence in the contralateral iliac flow should be avoided. Stent placement through the iliocaval confluence carries the risk of thrombosis or stenosis of the contralateral iliac vein owing to partial or complete obstruction of the contralateral iliac vein.³⁴ A systematic review revealed that the incidence of this complication could reach 15%.²⁴ In one of the included studies, 90% of the patients with contralateral thrombosis did not receive anticoagulant treatment at that time.³⁵ The authors of this review concluded that patients requiring a stent across the iliocaval confluence may benefit from long-term anticoagulant treatment.²⁴

There was no consensus regarding the role of endophlebectomy associated with temporary arteriovenous fistula in patients with severe involvement of the common femoral vein, which involves the ostia of the deep femoral vein and its branches. This technique is described as safe and effective in these patients, although there is little evidence on the creation of an arteriovenous fistula.^{36,37}

Although anticoagulation therapy in patients with DVT plays a key role in symptom control and functional recovery, clinical practice guidelines provide few recommendations regarding the management of anticoagulation after stent implantation, and when included, they are very generic.^{14,30} However, the use of anticoagulants in this setting varies widely.^{38–40} It is not surprising, therefore, that several other consensus attempts have been made on this aspect of stent management.³⁹ The participants in our Delphi process agreed that anticoagulation should be started early or immediately after stent implantation, that anticoagulation should initially be performed with low-molecular-weight heparins, and that anticoagulation should be maintained long term (at least the first 6 months) if the bleeding risk is low or moderate and if the DVT is idiopathic or caused by a minor transient risk factor. According to the guidelines, anticoagulation therapy is recommended for patients with thrombotic lesions but do not specify the duration or type of treatment.¹⁴ According to the European Society for Vascular Surgery, in patients who underwent thrombectomy with or without stent implantation, anticoagulation therapy should last at least as long as it would have lasted if the treatment had been conservative.³⁰ The Society of Interventional Radiology guidelines states that it should last “at least several months” in most patients with a history of DVT/PTS.¹⁴ The above-mentioned specific consensus on this topic indicates that anticoagulation should last 6 to 12 months after stent placement, and in patients with a history of multiple thromboses, anticoagulation should last throughout life.³⁹

There was no consensus on the addition of antiplatelet treatment to anticoagulation therapy during the first month or during the first 6 to 12 months (in contrast, 50% disagreed with these practices), although it is recommended in cases of discontinuation of anticoagulation therapy. Despite low quality of evidence and a weak strength of recommendation, the Society of Interventional Radiology considers it appropriate to add an antiplatelet agent to anticoagulant treatment for several months for the majority of patients with low bleeding risk.¹⁴ However, in the aforementioned consensus on anticoagulation therapy, there was no agreement on the use of antiplatelet treatment, although 55% of participants considered lifelong antiplatelet treatment necessary for patients with compressive lesions of the iliac vein.³⁹

In-stent thrombosis is possibly the most important complication of stent placement. A recent review concluded that the quality of anticoagulation therapy is an important factor for its selection but did not make recommendations in this regard.²⁵ Likewise, we did not find any recommendations for its management in the clinical practice guidelines. The experts who participated in this consensus agreed to consider thrombolysis for patients with in-stent thrombosis.

The experts of this consensus agreed that before discharge, it was advisable to perform Doppler ultrasound in the first 2 to 3 days and to closely monitor the patient during the first month. According to the guidelines, close clinical follow-up is recommended after stent placement to ensure compliance with anticoagulation therapy, monitor bleeding and symptom response, determine the need for reintervention to restore patency if the patient has a recurrence of symptoms, and monitor the appearance of late complications.¹⁴ However, they did not provide specific recommendations. Other experts recommend performing Doppler ultrasound in the first 24 hours after the procedure, at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months after the procedure and then annually thereafter for management.³² Finally, we believe that venous stents should be implanted only in centers able to immediately respond to emergency situations (e.g., migration, perforation, acute hemorrhage, acute thrombosis).

Conclusion

These consensus recommendations offer practical insights into optimizing venous stent use to prevent PTS in DVT patients. Addressing the critical aspects of stent selection, placement, and postprocedural care, these findings contribute to informed clinical decision-making. The identified areas of divergence underscore the nature of the consensus and require further investigation.

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Conflict of Interest

P.D.-R. has received honoraria from ROVI, Bayer, Techdow, Menarini, Leo Pharma, Pfizer, Bristol-Myers, Sanofi, and Daiichi-Sankyo. Additionally, he has been involved in advisory roles for Techdow, Leo Pharma, and Pfizer. The remaining authors have no conflicts of interest.

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References

- Cushman M. Epidemiology and risk factors for venous thrombosis. *Semin Hematol* 2007;44(02):62–69
- Huang J, Liu XY, Wu ZP, Ma YK. Quality of life status and influencing factors among patients with deep vein thrombosis. *Patient Prefer Adherence* 2022;16:949–956
- Galanaud JP, Holcroft CA, Rodger MA, et al. Predictors of post-thrombotic syndrome in a population with a first deep vein thrombosis and no primary venous insufficiency. *J Thromb Haemost* 2013;11(03):474–480
- Kahn SR, Shrier I, Julian JA, et al. Determinants and time course of the postthrombotic syndrome after acute deep venous thrombosis. *Ann Intern Med* 2008;149(10):698–707
- Kahn SR, Comerota AJ, Cushman M, et al; American Heart Association Council on Peripheral Vascular Disease, Council on Clinical Cardiology, and Council on Cardiovascular and Stroke Nursing. The postthrombotic syndrome: evidence-based prevention, diagnosis, and treatment strategies: a scientific statement from the American Heart Association. *Circulation* 2014;130(18):1636–1661
- Hansson PO, Sörbo J, Eriksson H. Recurrent venous thromboembolism after deep vein thrombosis: incidence and risk factors. *Arch Intern Med* 2000;160(06):769–774
- Schellong SM, Goldhaber SZ, Weitz JI, et al. Isolated distal deep vein thrombosis: perspectives from the GARFIELD-VTE registry. *Thromb Haemost* 2019;119(10):1675–1685
- Ortel TL, Neumann I, Ageno W, et al. American Society of Hematology 2020 guidelines for management of venous thromboembolism: treatment of deep vein thrombosis and pulmonary embolism. *Blood Adv* 2020;4(19):4693–4738
- Tran HA, Gibbs H, Merriman E, et al. New guidelines from the Thrombosis and Haemostasis Society of Australia and New Zealand for the diagnosis and management of venous thromboembolism. *Med J Aust* 2019;210(05):227–235
- Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease: antithrombotic therapy and prevention of thrombosis, 9th ed: American college of chest physicians evidence-based clinical practice guidelines. *Chest* 2012;141(2, Suppl):e419S–e496S
- Makedonov I, Kahn SR, Galanaud JP. Prevention and management of the post-thrombotic syndrome. *J Clin Med* 2020;9(04):923
- Black SA, Alvi A, Baker SJ, et al. Management of acute and chronic iliofemoral venous outflow obstruction: a multidisciplinary team consensus. *Int Angiol* 2020;39(01):3–16
- Breen K. Role of venous stenting for venous thromboembolism. *Hematology (Am Soc Hematol Educ Program)* 2020;2020(01):606–611
- Vedantham S, Weinberg I, Desai KR, et al. Society of interventional radiology position statement on the management of chronic iliofemoral venous obstruction with endovascular placement of metallic stents. *J Vasc Interv Radiol* 2023;34(10):1643–1657.e6
- Rossi FH, Kambara AM, Izukawa NM, et al. Randomized double-blinded study comparing medical treatment versus iliac vein stenting in chronic venous disease. *J Vasc Surg Venous Lymphat Disord* 2018;6(02):183–191
- van Vuuren TM, van Laanen JHH, de Geus M, Nelemans PJ, de Graaf R, Wittens CHA. A randomised controlled trial comparing venous stenting with conservative treatment in patients with deep venous obstruction: research protocol. *BMJ Open* 2017;7(09):e017233
- Meng QY, Li XQ, Jiang K, et al. Stenting of iliac vein obstruction following catheter-directed thrombolysis in lower extremity deep vein thrombosis. *Chin Med J (Engl)* 2013;126(18):3519–3522
- Taha MA, Busuttill A, Bootun R, Davies AH. A systematic review on the use of deep venous stenting for acute venous thrombosis of the lower limb. *Phlebology* 2019;34(02):115–127
- Williams ZF, Dillavou ED. A systematic review of venous stents for iliac and venacaval occlusive disease. *J Vasc Surg Venous Lymphat Disord* 2020;8(01):145–153
- Ferreira AM, Oliveira-Pinto J, Duarte-Gamas L, Coelho A, Mansilha A. Mid-term patency of iliac venous stenting for post-thrombotic syndrome. *Int Angiol* 2021;40(03):196–205
- Badesha AS, Bains PRS, Bains BRS, Khan T. A systematic review and meta-analysis of the treatment of obstructive chronic deep venous disease using dedicated venous stents. *J Vasc Surg Venous Lymphat Disord* 2022;10(01):267–282.e4
- Sayed MH, Salem M, Desai KR, O'Sullivan GJ, Black SA. A review of the incidence, outcome, and management of venous stent migration. *J Vasc Surg Venous Lymphat Disord* 2022;10(02):482–490
- Badesha AS, Siddiqui MM, Bains BRS, Bains PRS, Khan T. A systematic review on the incidence of stent migration in the treatment of acute and chronic iliofemoral disease using dedicated venous stents. *Ann Vasc Surg* 2022;83:328–348
- Duarte-Gamas L, Rocha-Neves JP, Pereira-Neves A, Dias-Neto M, Baekgaard N. Contralateral deep vein thrombosis after stenting across the ilioacaval confluence in chronic venous disease - a systematic review. *Phlebology* 2020;35(04):221–230
- Notten P, van Laanen JHH, Eijgenraam P, et al. Quality of anticoagulant therapy and the incidence of in-stent thrombosis after venous stenting. *Res Pract Thromb Haemost* 2020;4(04):594–603
- Jones J, Hunter D. Consensus methods for medical and health services research. *BMJ* 1995;311(7001):376–380
- Diamond IR, Grant RC, Feldman BM, et al. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol* 2014;67(04):401–409
- Vedantham S, Desai KR, Weinberg I, et al. Society of interventional radiology position statement on the endovascular management of acute iliofemoral deep vein thrombosis. *J Vasc Interv Radiol* 2023;34(02):284–299.e7
- Mazzolai L, Aboyans V, Ageno W, et al. Diagnosis and management of acute deep vein thrombosis: a joint consensus document from the European Society of Cardiology working groups of aorta and peripheral vascular diseases and pulmonary circulation and right ventricular function. *Eur Heart J* 2018;39(47):4208–4218
- Kakkos SK, Gohel M, Baekgaard N, et al; Esvs Guidelines Committee. Editor's choice - European society for vascular surgery (ESVS) 2021 clinical practice guidelines on the management of venous thrombosis. *Eur J Vasc Endovasc Surg* 2021;61(01):9–82
- Taha MAH, Busuttill A, Bootun R, et al. A clinical guide to deep venous stenting for chronic iliofemoral venous obstruction. *J Vasc Surg Venous Lymphat Disord* 2022;10(01):258–266.e1
- Lim CS, Black SA. Mechanical characteristics of venous stents to overcome challenges of venous outflow obstruction. *Int Angiol* 2022;41(03):240–248
- Machado H, Sousa J, Mansilha A. The impact of venous stenting across the inguinal ligament on primary patency: a systematic review. *Int Angiol* 2021;40(04):270–276
- Neglén P, Darcey R, Olivier J, Raju S. Bilateral stenting at the ilioacaval confluence. *J Vasc Surg* 2010;51(06):1457–1466

- 35 Le TB, Lee TK, Park KM, Jeon YS, Hong KC, Cho SG. Contralateral deep vein thrombosis after iliac vein stent placement in patients with May-Thurner syndrome. *J Vasc Interv Radiol* 2018;29(06):774–780
- 36 Dumantepe M, Aydin S, Ökten M, Karabulut H. Endophlebectomy of the common femoral vein and endovascular iliac vein recanalization for chronic iliofemoral venous occlusion. *J Vasc Surg Venous Lymphat Disord* 2020;8(04):572–582
- 37 De Maeseneer MG, Kakkos SK, Aherne T, et al; Esvs Guidelines Committee. Editor's choice - European society for vascular surgery (ESVS) 2022 clinical practice guidelines on the management of chronic venous disease of the lower limbs. *Eur J Vasc Endovasc Surg* 2022;63(02):184–267
- 38 Notten P, Ten Cate H, Ten Cate-Hoek AJ. Postinterventional antithrombotic management after venous stenting of the iliofemoral tract in acute and chronic thrombosis: a systematic review. *J Thromb Haemost* 2021;19(03):753–796
- 39 Milinis K, Thapar A, Shalhoub J, Davies AH. Antithrombotic therapy following venous stenting: international delphi consensus. *Eur J Vasc Endovasc Surg* 2018;55(04):537–544
- 40 Xiao N, Genet M, Khaja M, Desai KR. Antithrombotic therapy after deep venous intervention. *Semin Intervent Radiol* 2022;39(04):357–363



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