

Significance of Partial or Complete Thrombosis of the Common and Deep Femoral Vein in Patients With Deep Vein Thrombosis

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WHAT THIS PAPER ADDS

This study suggests the importance of a thorough ultrasound examination when examining patients suspected of having deep vein thrombosis (DVT), including examination of the deep femoral vein. DVT only reaching the inguinal ligament probably has partial thrombus in the common femoral vein due to inflow from the deep femoral vein. An occlusive thrombus in the deep femoral vein should raise the suspicion of thrombus in the iliac veins.

Objective: The aim was to assess the anatomical distribution of acute deep venous thrombosis (DVT) with a focus on iliofemoral DVT, and, in particular, to characterise thrombus in the common femoral vein (CFV) and the deep femoral vein (DFV).

Methods: A one year prospective study including patients older than 18 years of age with an acute first time DVT according to ultrasound examination at one of three university hospitals in Copenhagen, Denmark. Thrombus location and extent were registered and divided into five segments: calf veins; popliteal vein; femoral and deep femoral vein; common femoral vein; and iliac veins and/or the inferior vena cava. Thrombus appearance of the CFV and the DFV (partial or occlusive) was examined in detail.

Results: Acute DVTs were identified in 203 extremities in 200 patients (58% male). The median age of the patients was 68 years (range 19–92 years), and left-sided DVT was observed in 56%. Iliofemoral DVT was present in 54 (27.0%) patients. Thrombus involving the CFV but not the iliac veins (CFV group) was seen in 28 patients; the remaining 26 had involvement of the iliac veins (iliac group). Thrombus in the CFV was more likely to be occlusive in the iliac group than in the CFV group (77% vs. 4%; $p < .001$). Thrombus in the DFV was more often occlusive in the iliac group than in the CFV group (81% vs. 11%; $p < .001$). The DFV was free of thrombus in 12% of patients in the iliac group and in 64% of those in the CFV group.

Conclusion: The presence of occlusive thrombus in the CFV and/or in the DFV pointed to a DVT also involving the ipsilateral iliac veins. Thrombosis of the deep leg veins extending into the CFV below the inguinal ligament was more likely to be partial in the CFV, mainly due to inflow from the DFV.

Keywords: Deep venous thrombosis (DVT), Ultrasound, Iliofemoral DVT, Common femoral vein (CFV), Deep femoral vein, Complete and partial thrombosis

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INTRODUCTION

In most of the current literature, the anatomical location of deep vein thrombosis (DVT) is referred to as “proximal” or “distal”, with the threshold being involvement of the popliteal vein (PV) in the “proximal” segment. The use of

the terms proximal and distal may be too imprecise and insufficient, resulting in difficulties stratifying patients to different treatment modalities and comparing treatment outcomes.

Only a few studies have aimed at further describing the anatomical distribution of DVTs. Some years ago, a sub-classification of proximal DVT into femoropopliteal and iliofemoral DVT was suggested,¹ with iliofemoral DVT referring to complete or partial thrombosis of any part of the iliac vein and/or common femoral vein (CFV), with or without other associated veins.² Most of the focus has been

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on iliofemoral DVT, as these patients tend to have the worst prognosis when treated with anticoagulants alone and their risk of post-thrombotic syndrome tends to be high.^{3,4}

In a recent retrospective analysis of 1338 patients older than 18 years with acute unilateral lower limb DVT, the anatomical site and extent of thrombus were recorded and divided into five venous segments: calf veins; PV; femoral vein (FV); CFV; and iliac veins with or without inferior vena cava (IVC). One group of patients was seen to have thrombosis including the CFV, reaching the inguinal ligament but not extending more proximally.⁵ In this study, involvement of the deep femoral vein or deep FV (DFV) was not characterised, which was described as a limitation.

Only a few studies have reported the incidence of thrombus involving the DFV.^{6–9} Identification of thrombus in this vein may play an important role as this vein drains the inner thigh, plays a significant role as a supplementary system in the drainage of the lower extremity, and may play a more important role as a compensatory outflow channel in patients with previous DVT and post-thrombotic changes in the FV.¹⁰ The presence of thrombus in the DFV is, however, poorly characterised in the literature and is not assessed separately in several reporting systems.

The objective of this study was to assess the precise anatomical location of first time acute DVT with a focus on iliofemoral DVTs, and, in particular, characterising thrombus in the CFV and the DFV with a partial or occlusive appearance.

The hypothesis was that in the case of an acute thrombus in the deep leg veins extending into the CFV below the inguinal ligament, inflow from a patent DFV may serve as a mechanism of protection against iliac extension. In contrast, for an occluding thrombus in both the DFV and the FV, more proximal involvement of the iliac veins was expected.

MATERIALS AND METHODS

Patients older than 18 years of age were recruited prospectively over a 12 month period from June 2017 to June 2018 from three university hospitals in Copenhagen (Herlev and Gentofte Hospital, Departments of Radiology; and Frederiksberg Hospital, Department of Clinical Physiology and Nuclear Medicine).

Duplex ultrasound examinations were performed to check for the presence of a lower extremity DVT in patients, referred to one of the three hospitals, presenting with a suspected acute DVT. Only the symptomatic leg was examined. At Herlev and Frederiksberg Hospitals the ultrasound equipment included high-end ultrasound scanners (Philips Epiq 7 and iU22; Philips Healthcare, Andover, MA, USA) with a linear high frequency vascular probe (3.0–12.0 MHz and 3.0–9.0 MHz, respectively). At Gentofte Hospital a high-end ultrasound scanner (Logiq E9; General Electric, Milwaukee, WI, USA) with a linear high frequency vascular probe (6.0–9.0 MHz) was used. The iliac veins were examined with the linear transducer using a virtual convex function and alternative convex transducers (3–

6 MHz; GE C1-6 and Philips C5-1). All examinations were performed by trained vascular technologists or physicians, all experienced in vascular sonography.

The ultrasound examinations were performed with focus on the deep venous system, examining the CFV, the FV, the DFV, the PV, and the anterior tibial, posterior tibial, and peroneal veins. The superficial veins, i.e., the great saphenous vein (GSV), were not routinely examined for thrombus. All veins were examined continuously in the cross sectional scan plane with conventional compression test in B-mode. Next, colour Doppler was applied to visualise flow and augmentation of flow with distal manual compression. Longitudinal scans of the CFV were also performed routinely (Fig. 1), and the presence or absence of a phasic flow pattern was visualised with pulsed wave Doppler. If there was a pathological flow pattern or thrombus in the CFV, the iliac veins and the IVC were also examined. In patients that were difficult to examine, i.e., very obese patients, the external iliac vein was examined. The proximal part of the DFV was examined in a longitudinal scan plane for approximately 5 cm and followed for approximately 10–15 cm in the transverse scan plane. Thrombus was characterised as partial or occluding in the respective vein segments. Thrombus was characterised as partial when spontaneous flow was visible around the thrombus demonstrated by colour Doppler. In case of no spontaneous flow around the thrombus, a gentle manual pressure of the leg distal to the segment examined was applied. When no flow was seen in the venous lumen with colour Doppler, thrombus was characterised as occlusive. Examinations positive only for muscular calf vein thrombosis or superficial vein thrombosis were excluded from analysis. Only first time acute DVTs were included, corresponding to thrombus and/or symptom duration for a maximum of 14 days.²

When DVT was confirmed, an electronic report form, including a description that characterised the location and extent of thrombus, was completed and saved in the hospitals' picture archiving and communication systems.

Later, the ultrasound examinations were reviewed and interpreted by three medical doctors (one radiologist, one

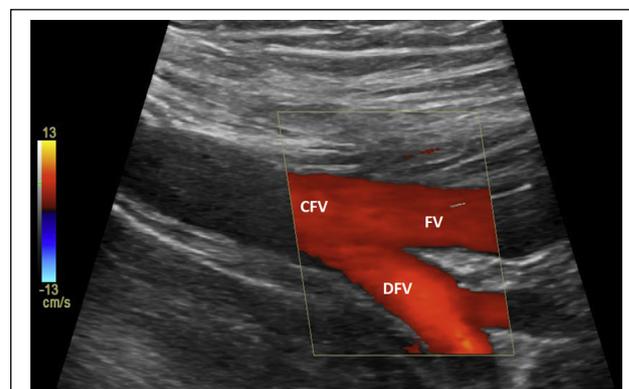


Figure 1. A normal confluence of the femoral vein (FV) and the deep femoral vein (DFV) continuing into the common femoral vein (CFV) visualised by colour Doppler.

vascular surgeon, and one specialist in clinical physiology and nuclear medicine), meaning that all thrombus descriptive forms and corresponding images from the examinations were reviewed. From this information, a study database was created, with additional recording of the affected side (left or right) and the extent of the thrombus, as well as basic demographic data, including the age and sex of the patient.

In the analyses, five vein segments were identified corresponding to calf veins (anterior and posterior tibial veins and the peroneal veins; segment 1), PV (segment 2), FV and the DFV (segment 3), CFV (segment 4), and external/common iliac veins with or without IVC involvement (segment 5), in accordance with the segments presented by De Maeseneer *et al.*⁵

In patients with iliofemoral DVT two groups were described and examined: a group with DVT involving the CFV but not extending more proximally (CFV group) and a group with thrombus also involving the iliac veins (iliac group). These groups were compared with respect to characteristics of the CFV and the DFV (occlusive or partial DVT) and to the affected side of the DVT (left vs. right). Finally, segment involvement in the patients with iliofemoral DVT was described.

Statistical analysis

No power analysis was performed prior to the study as the focus of this paper was to characterise thrombus location in incident, acute DVTs with particular focus on the CFV and the DFV. Data were analysed with SAS statistical software version 9.4 (SAS Institute, Cary, NC, USA). Categorical variables were analysed using chi-square tests and a p value $< .05$ was considered statistically significant. For expected values < 5 , Fisher's exact test was used. Examinations with missing data were excluded from analysis.

All patients gave informed consent and the Danish Data Protection Agency approved the study (no. 2012-58-0004).

RESULTS

Acute DVT was identified in 221 extremities; however, 18 patients were excluded because of an inability to provide informed consent or because they did not wish to participate. In total, 203 extremities in 200 patients were included in the analyses. The median age of the patients was 68 years (range 19–92 years), 58% were male, and in 56% of the patients the DVT was left-sided. In total, 81 (40.5%) of the 200 patients were examined at Herlev Hospital, 76 (38.0%) at Gentofte Hospital, and 43 (21.5%) at Frederiksberg Hospital.

In 47 extremities (23.1%) thrombosis was located exclusively in one segment, of which 42 had thrombosis isolated to the calf veins. In 48 extremities (23.6%) DVT was observed in two segments, and in 61 extremities (30.0%) thrombosis was located in three segments. DVT in all five vein segments was seen in 20 extremities (9.8%; Table 1). The iliac veins were thrombosed in 13% of extremities, the CFV in 27%, the FV in 58%, the DFV in 17%, and the PV in

Table 1. Distribution of the extent of thrombus in 203 extremities with acute deep vein thrombosis (DVT)*

Segment	n (%)
<i>DVT in one segment</i>	47 (23.1)
Segment 1 [†]	42
Segment 2 [‡]	4
Segment 3 [§]	1
<i>DVT in two segments</i>	48 (23.6)
Segment 1 + 2	38
Segment 2 + 3	9
Segment 4 + 5 [¶]	1
<i>DVT in three segments</i>	61 (30.0)
Segment 1 + 2 + 3	55
Segment 2 + 3 + 4	2
Segment 3 + 4 + 5	4
<i>DVT in four segments</i>	27 (13.5)
Segment 1 + 2 + 3 + 4	26
Segment 2 + 3 + 4 + 5	1
<i>DVT in five segments</i>	20 (9.8)
Segment 1 + 2 + 3 + 4 + 5	20
Total	203

* Three patients had bilateral DVT.

[†] Segment 1: crural veins.

[‡] Segment 2: popliteal vein.

[§] Segment 3: femoral vein and deep femoral vein.

^{||} Segment 4: common femoral vein.

[¶] Segment 5: iliac veins with or without inferior vena cava.

76%. The posterior tibial veins were affected in 69%, the peroneal veins in 59%, and the anterior tibial veins in 27%.

In total, 54 (27.0%) had an iliofemoral DVT, corresponding to complete or partial thrombosis of the iliac veins and/or the CFV with or without involvement of the femoropopliteal segment. Of these, 28 patients had thrombus involving the CFV but not the iliac veins (CFV group; Table 2). The remaining 26 had involvement of the iliac veins (iliac group). Thrombus in the CFV was more likely to be occlusive in the iliac group than in the CFV group (77% vs. 4%; $p < .001$). Furthermore, thrombus in the DFV was more often occlusive in patients in the iliac group than in those in the CFV group (81% vs. 11%; $p < .001$). In the CFV group the remaining 89% with non-obstructive thrombus either had partial thrombus in the DFV (25%) or a patent DFV (64%; Table 2). There was a predominance of left extremities affected in patients in the iliac group (73% vs. 32%; $p = .003$).

In the iliac group, most patients ($n = 20$) had involvement of segments 1–5, and in this group the thrombus could have originated either in the iliac veins or distally. This is also true for one patient with involvement of segment 2–5. Of the four patients who had involvement of segments 3–5, thrombus most likely originated in the iliac vein in three patients, and in the FV in one patient. One patient had involvement of segments 4–5 with an iliac origin of the thrombus (data not shown).

Characteristics of segment involvement according to the affected extremity and according to characteristics of thrombus in the CFV are shown in Table 3. Segments 1–5 were involved in most left leg ($n = 15$) and in CFV occlusive

Table 2. Characteristics of 54 iliofemoral deep vein thromboses (DVTs)

	Common femoral vein group (n = 28)	Iliac group (n = 26)	p value
<i>Common femoral vein thrombus</i>			<.001*
Occlusive	1 (4)	20 (77)	
Partial	27 (96)	6 (23)	
<i>Deep femoral vein thrombus</i>			<.001†
Occlusive	3 (11)	21 (81)	
Partial	7 (25)	2 (8)	
Patent	18 (64)	3 (12)	
<i>Side of DVT</i>			.003*
Left extremity	9 (32)	19 (73)	
Right extremity	19 (68)	7 (27)	

Data are n (%). * Chi-square test. † Fisher's exact test.

thrombi (n = 16), whereas segments 1–4 were more often involved in right leg (n = 18) and CFV partial thrombi (n = 26).

In the CFV group, three patients were identified with an occlusive DFV. Two of these patients were described with both an occlusive thrombus in the FV and the DFV. Both patients had a partial thrombus in the CFV due to inflow from the GSV. In the third patient with an occlusive thrombosis of the DFV, the CFV presented with a non-occluding thrombus due to inflow from a partially thrombosed FV.

No difference was found between thrombus involvement of the FV between the two groups (100% involvement [n = 28] in the CFV group, 96% involvement [n = 25] in the iliac group; p = .24). However, a difference was observed for involvement of the PV (100% involvement [n = 28] in the CFV group, 81% involvement [n = 21] in the iliac group; p = .02).

DISCUSSION

In the present study, which included 203 extremities with first time acute DVTs, it was found that 30% of patients had DVT in three segments, with the most commonly found DVT being the combination of segments 1 + 2 + 3, corresponding to calf veins, PV, and FV, which is in agreement with the observations of De Maeseneer *et al.*⁵ Furthermore, it was found that 54 (27%) of the patients had an iliofemoral DVT, which is slightly lower than in the latter study, in which the corresponding number was 38%. In addition it was seen that patients in the iliac group had more occlusive CFV and DFV than patients in the CFV group. Furthermore, a left-sided predominance was observed for the iliac group (73%).

These findings are not surprising. In cases in which thrombus originates in the iliac veins as a result of iliac vein compression syndrome,^{11,12} occluding thrombus in the iliac outflow tract will increase the risk of occluding thrombus in the CFV, the FV, and the DFV due to decreased outflow. Additionally, the observation of a left-sided predominance

Table 3. Segment involvement according to affected side of extremity and characteristics of thrombus in the common femoral vein in 54 iliofemoral deep vein thromboses

Segment involvement	Affected extremity		Common femoral vein thrombus	
	Left leg	Right leg	Occlusive	Partial
	(n = 28)	(n = 26)	(n = 21)	(n = 33)
1–5	15	5	16	4
1–4	8	18	0	26
2–5	0	1	1	0
3–5	3	1	3	1
2–4	1	1	1	1
4–5	1	0	0	1

Segment 1 = crural veins; segment 2 = popliteal vein; segment 3 = femoral vein and deep femoral vein; segment 4 = common femoral vein; segment 5 = iliac veins with or without inferior vena cava.

in the iliac group can be explained by the abovementioned syndrome, with compression of the left common iliac vein between the crossing of the right common iliac artery and the fifth lumbar vertebra. Furthermore, an occluding thrombus in both the FV and the DFV will increase the risk of an occlusive thrombus in the CFV with involvement of the iliac veins, due to decreased inflow.

In the CFV group, 96% of patients were found to have a partial thrombus in the CFV and only one patient had an occlusive thrombus. This can be explained by the fact that the majority of the DFVs in this group were patent or only partially thrombosed. Inflow from the DFV, and, to a lesser extent, from the GSV, can prevent thrombus from occluding the CFV and involving the iliac veins (Fig. 2A and B).

This study was inspired by the findings of the study by De Maeseneer *et al.*,⁵ and their findings were questioned in a group of patients with DVT reaching the inguinal ligament and not extending further.⁵ It was further demonstrated that patients with DVT reaching the inguinal ligament and not involving the iliac veins most likely have a partial thrombus in the CFV due to inflow from the DFV. Inflow from the GSV, if present, may also prevent further propagation of thrombus.

In a recent study by Repella *et al.*,⁹ examinations were divided into two groups based on involvement of the DFV, i.e., proximal DVT with DFV involvement vs. proximal DVT without DFV involvement. Overall, it was concluded from this study that proximal DVT with DFV involvement was associated with a higher thrombus burden, more frequent DVT in the external iliac and femoropopliteal veins, and a higher likelihood of having a hypercoagulable disorder. However, in that study, the authors did not define whether thrombus was occlusive or partial, and included patients both with acute DVTs and with chronic post-thrombotic changes.⁹

The DFV is an important component of the drainage of the lower limb, and patency of this vein should be reported as it can influence the clinical outcome and possibly also decision making regarding treatment (thrombolysis/

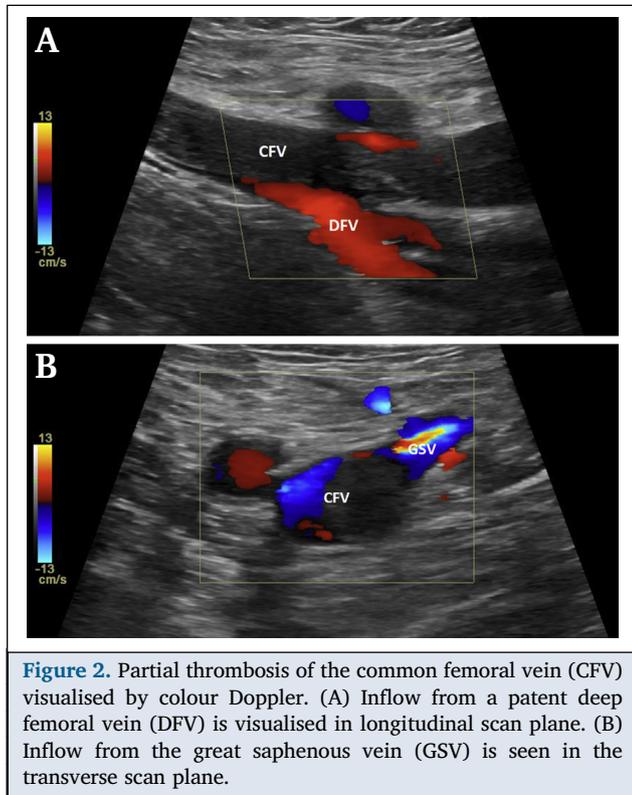


Figure 2. Partial thrombosis of the common femoral vein (CFV) visualised by colour Doppler. (A) Inflow from a patent deep femoral vein (DFV) is visualised in longitudinal scan plane. (B) Inflow from the great saphenous vein (GSV) is seen in the transverse scan plane.

thrombectomy). When there is thrombus in the DFV, as well as in the iliac veins, thrombolysis/thrombectomy might be preferred. Moreover, the DFV may play a significant role as a supplementary system in the drainage of the lower extremity, especially in patients with previous DVT and chronic post-thrombotic changes in the FV.

Some other studies have focused on thrombosis in the DFV. In a recent retrospective analysis of 637 patients, it was found that the most frequently thrombosed segments were popliteal vein (74%), posterior tibial vein (74%), and DFV (74%).⁷ They found that the DFV was frequently thrombosed in patients with malignancy and a history of surgery.⁷ It was found in this study that the most frequently thrombosed vein segment was the popliteal (76%), posterior tibial (69%), peroneal (59%), and femoral (58%) vein. The DFV was affected in only 17% of the patients in the present study. Information about risk factors was not recorded herein.

Labropoulos *et al.* studied isolated thrombosis in unusual sites of the lower extremity veins, such as the DFV, femoropopliteal vein, deep external pudendal vein, etc.⁸ Patients with DVT in all thigh veins but the FV were included. Of 2568 patients with DVT, isolated thrombosis in unusual sites was observed in 14 patients, corresponding to .54%, of which eight were DFV thromboses. The present results cannot be compared with the abovementioned observations; however, these authors emphasised that DFV DVT in combination with DVT in other axial veins is expected to be more common than isolated DVT in unusual sites and that this should be expected to have a much more severe acute and chronic symptomatology. This emphasises the

importance of a routine ultrasound examination of the DFV in patients suspected of having DVT.

When an occlusive thrombus is observed in the DFV, this should raise the suspicion of thrombus in the iliac veins. Furthermore, it is important to characterise thrombus as being either partial or occlusive. Therefore, it is necessary to use supplementary colour and pulsed wave Doppler routinely.

The present study has some limitations. Overall, it is important to be aware that thrombus formation is a dynamic process and that the findings of the ultrasound examination are time dependent. Furthermore, there was no information about DVT risk factors, i.e., if the thrombus was provoked or unprovoked, and symptomatology was not recorded. The accuracy of the ultrasound examination of thrombus involvement in the abdominal and pelvic veins may have been limited in some patients. However, all patients with a pathological velocity curve or thrombus in the CFV had their external iliac vein evaluated. The superficial veins were not routinely examined, i.e., the GSV in the groin; however, it was described in some examinations. Finally, there are no long-term outcome data, so the clinical importance of the status of the DFV remains to be investigated.

In conclusion, this study underscores the importance of a thorough ultrasound examination when examining patients suspected of DVT, including examination of the DFV. DVT extending from the deep leg veins into the CFV, distally from the inguinal ligament, most likely includes partial thrombus in the CFV, mainly due to inflow from the DFV. An occlusive thrombus in the CFV and/or in the DFV should always raise the suspicion of thrombus in the iliac veins. Future research concerning the clinical importance of the status of the DFV in patients with iliofemoral DVT is warranted.

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CONFLICTS OF INTEREST

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