High Prevalence of Detectable Deep Venous Thrombosis in Patients With Acute Pulmonary Embolism*

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Study objectives: Because specific studies are unavailable, the exact prevalence of detectable “residual” deep venous thrombosis (DVT) in patients with acute pulmonary embolism (PE) is unknown.

Design: Review of clinical records and radiologic documents of consecutive patients.

Setting: Pulmonary diseases and radiology departments at a university hospital.

Patients: All patients hospitalized in the Department of Pulmonary Diseases with a diagnosis of acute PE during a 5-year period (1984 to 1988). During this period, the diagnosis of PE was based exclusively on pulmonary angiography, and bilateral lower limb venography was routine in patients with proven acute PE.

Measurements and results: Among 228 consecutive patients with angiography-proven PE, 213 underwent bilateral lower limb venography within 48 h of the diagnosis. Venography demonstrated DVT in 174 patients (81.7%; 95% confidence interval, 76.5 to 86.9%), including 128 patients (60%) with proximal DVT. Signs or symptoms of DVT were present in only 72 patients (42%) with DVT. The prevalence of detectable DVT was significantly lower in patients with recent pelvic surgery or delivery (6 of 12, 50%) than in the other patients, whatever their individual risk factors (p < 0.05). The mean pulmonary vascular obstruction was significantly lower in patients with normal venography than in patients with detectable DVT (37.6 ± 20.9% vs 48.4 ± 21.7%; p = 0.007).

Conclusions: Lower limb venography demonstrates a high prevalence (82%) of residual DVT in patients with angiography-proven PE. These data should be taken into account in the diagnostic and therapeutic management of patients with suspected or proven PE.

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Key words: deep venous thrombosis; phlebography; pulmonary angiography; pulmonary embolism

Abbreviations: DVT = deep venous thrombosis; IVC = inferior vena cava; PE = pulmonary embolism; PVO = pulmonary vascular obstruction; US = ultrasonography

Pulmonary embolism (PE) is the most severe complication of deep venous thrombosis (DVT). Because both conditions require anticoagulant treatment and clinical signs and symptoms are unreliable for diagnosing either DVT or PE,1 objective tests must be performed to confirm or exclude these diagnoses. Although venous compression ultrasonography (US), ventilation-perfusion lung scanning, D-dimer tests, and spiral CT are used routinely and/or increasingly, the gold standard diagnostic tests for PE and DVT remain pulmonary angiography and venography, respectively.1,2

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About 50% of patients with proven proximal DVT have an associated PE, which is asymptomatic in > 50% of cases.3–6 On the other hand, in patients with proven acute PE, the prevalence of detectable “residual” DVT is largely unknown because no specific studies are available, and the very few studies in which such data can be found provide discrepant results, with the prevalence of DVT ranging from 13 to 93%.7–11 These discrepancies may be explained at least in part by the
heterogeneity of the diagnostic criteria for PE and DVT both between and within these studies.

In the mid 1980s, it was our routine practice to search for DVT in all patients with proven PE, and to rely only on pulmonary angiography and venography to diagnose PE and DVT, respectively. At that time in France, many centers advocated systematic venography in patients with PE to identify patients with both PE and proximal (eventually free-floating) DVT because such patients were thought to present an indication for inferior vena cava (IVC) interruption. In fact, part of the obtained data helped us to support more restrictive indications for IVC interruption, and even paved the way for a prospective controlled study on IVC filters. Furthermore, especially with the availability of compression US, venography has not been routinely used in this context since the late 1980s. Therefore, it is of interest to report what seems to be, and is likely to remain, a unique experience in patients with venous thromboembolic disease. These descriptive data should provide a reliable estimation of the prevalence of detectable DVT in various groups of patients with acute PE, and such information may constitute an important reference basis for the further developments of diagnostic and therapeutic strategies in patients with suspected or proven PE.

**Materials and Methods**

The data here presented were collected in 1989, and were not published earlier (except in abstract form), mainly because in the early 1990s, it seemed likely that venous US would rapidly and easily provide similar information on a prospective basis. This subsequently proved to be partly wrong, which led us to reconsider publication.

In 1989, a systematic review of the records of all patients hospitalized in the Department of Pulmonary Diseases at Antoine Béclère Hospital between January 1, 1984, and December 31, 1988 was undertaken to identify patients with a diagnosis of acute PE. This period was chosen because during these 5 years, the routine practice of the department was to base the diagnosis of PE on the results of pulmonary angiography exclusively, and to perform lower limb venography in all patients with a proven diagnosis of PE, whatever their signs or symptoms in the lower extremities. Thus, only patients with a contraindication to venography or obvious signs or symptoms of thrombosis in the superior caval venous system were not candidates for lower limb venography during this period. Detailed examination of the files and records of all patients with a diagnosis of acute PE was then performed, especially with regard to the risk factors for thromboembolic disease, the degree of pulmonary vascular obstruction (PVO) assessed by Miller’s index, signs or symptoms of DVT, and the results of bilateral lower limb venography, if any.

All available radiologic documents were reviewed by a panel of experienced pulmonary and radiology specialists, to either confirm or precise the degree of PVO and the interpretation of lower limb venography. For the 5% of the original radiologic documents that were unavailable, the original report of the radiologist was used instead of the panel reinterpretation.

**Pulmonary Angiography**

The pulmonary angiography technique used during the study period has been described elsewhere. The pulmonary artery catheter was inserted through an arm vein (basilic vein) in 92% of patients. Whatever the acquisition technique (conventional or digital), contrast injections were performed successively in the right (anteroposterior views) and left (left anterior oblique views) pulmonary arteries, with eventual further supraselective injections and profile views depending on the results of the first injections.

The diagnosis of pulmonary embolism required the presence of at least one intraluminal filling defect or sharp arterial cut-off within an opacified artery.

The scoring system described by Miller et al was used to evaluate the degree of PVO. Results were expressed in percentages (patient’s score divided by the maximum score of 34).

**Lower Limb Venography**

Throughout the study period, only the long-leg technique was used in the radiology department of the hospital. Briefly, the long-leg technique is performed by simultaneous bolus injection of 50 to 60 mL of contrast medium through a dorsal vein of each foot with the patient in the supine position. Three tourniquets are placed on each leg (ankle, below and above the knee). Four to six anteroposterior views of the whole venous system (from the ankle to the abdomen) are taken while tourniquets are removed successively from the ankle to the thigh. The last image is taken during a Valsalva maneuver after an upward tilting of both legs, to ensure a satisfactory visualization of the iliac veins and the IVC. This technique has been shown to be superior to the classic technique of Robinov and Paulin in terms of adequacy for interpretation and interobserver agreement.

The diagnosis of DVT required the visualization of at least one intraluminal filling defect within an opacified vein. All thrombosed venous segments were recorded: distal (below the popliteal vein), popliteal, femoral, iliac, and caval.

**Statistical Methods**

Mean values and SDs were calculated using standard formulas. The comparisons between mean values were made using Student’s t test. The χ² test was used for the comparison of observed percentages.

**Results**

Between January 1, 1984, and December 31, 1988, 228 consecutive patients admitted to the Department of Pulmonary Diseases had a diagnosis of acute PE proved by angiography. Among them, only 15 patients (6.5%) did not undergo lower limb venography within 48 h of the diagnosis of PE, mainly because of fatal PE (seven patients). Thus, 213 patients with acute PE underwent contemporary lower limb venography and constitute the subjects of this study.

There were 106 men and 107 women, with a mean age (± SD) of 58.7 ± 17.6 years old (range, 17 to 90 years old). Ninety-two percent of all angiographic and venographic documents were available for re-
view. The original report of the radiologist was available in all other cases. We compared a sample of the panel reinterpretations with the original reports and found no significant differences, especially with regard to the presence or absence of DVT on venograms and the degree of PVO on angiograms.

Lower limb venography demonstrated DVT in 174 patients (81.7%; 95% confidence interval, 76.5 to 86.9%), including 128 patients (60%; 95% confidence interval, 53.5 to 66.7%) with proximal DVT; the findings were considered normal in 32 patients. Venography was considered inadequate in seven patients (only one leg and/or poor quality). Signs or symptoms of DVT were present in 72 patients (42%) with DVT. Venography was a contributory cause of acute renal failure requiring temporary hemodialysis in one patient (0.5%).

The main risk factors for venous thromboembolic disease and the results of venography in each group are listed in Table 1. Only the prevalence of detectable DVT in patients with recent pelvic surgery (6 of 12, 50%) was significantly different from that observed in all other categories of patients (p < 0.05 in all cases).

The upper level of venous thromb in patients with DVT is presented Table 2. Among the 174 patients with DVT, 17 (10%) had bilateral thromboses, including seven patients (4%) with bilateral proximal DVT. Only four patients with proximal DVT had thrombi limited to the iliac veins and/or inferior vena cava without involvement of more distal veins.

The mean PVO (± SD) was 46.4 ± 21.9% (range, 6 to 90%). The mean percentage of PVO was not significantly different between groups of patients with various upper levels of DVT, but it was significantly higher in patients with DVT, whatever the upper level, than in patients without detectable DVT (Table 3). Accordingly, the prevalence of DVT was significantly lower in the 108 patients in whom PVO was < 50% than in the 105 patients whose PVO ≥ 50% (prevalences of 72.2% and 90.5%, respectively; p < 0.001). The proportions of proximal and calf DVT were not significantly different between patients with PVO ≥ 50% or < 50% (calf DVT, 33% vs 24%, respectively; p = 0.18).

**Discussion**

Using the two gold standard diagnostic tests for PE and DVT, we found that 82% of patients with acute PE still had detectable DVT at the time of PE diagnosis, and that DVT was asymptomatic in nearly two thirds of these patients. Unsurprisingly, the prevalence of DVT that could be detected by lower limb venography was significantly lower in patients with recent pelvic surgery or delivery (50%) than in the other patients (79 to 90%). Finally, the likelihood of detecting DVT was found to depend also on the severity of PE, with a significantly higher prevalence of DVT in patients with more severe PE.

Very few published series allow the estimation of the prevalence of detectable DVT in patients with proven PE, and report a wide range of results (ranging from 13 to 93%); our study provides the second highest prevalence rate (Table 4). The very low estimates in studies using venous US8,9 may be readily explained by the low sensitivity of US for detecting asymptomatic DVTs19–21 and by the fact that calf veins, iliac veins, and vena cava were not even investigated in these studies. Only the study by Hull et al7 used pulmonary angiography and venography in some of 139 patients with suspected PE. In a subset of 41 patients with angiography-proven PE, lower limb venography showed residual venous thrombi in 29 (71%). However, the proportions of

<table>
<thead>
<tr>
<th>Risk Factor*</th>
<th>No. of Patients (% of 213 Patients)</th>
<th>No. With DVT at Lower Limb Venography (rate in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of venous thromboembolism</td>
<td>22 (10)</td>
<td>20 (90)</td>
</tr>
<tr>
<td>Evolving cancer</td>
<td>32 (15)</td>
<td>27 (84)</td>
</tr>
<tr>
<td>Recent surgery or trauma (&lt; 1 mo)</td>
<td>47 (22)</td>
<td>33 (70)</td>
</tr>
<tr>
<td>Abdominal</td>
<td>10</td>
<td>8 (80)</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>18</td>
<td>16 (89)</td>
</tr>
<tr>
<td>Pelvic†</td>
<td>12</td>
<td>6 (50)</td>
</tr>
<tr>
<td>Miscellaneous‡</td>
<td>7</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Other§</td>
<td>17 (8)</td>
<td>14 (82)</td>
</tr>
<tr>
<td>None identified</td>
<td>111 (52)</td>
<td>88 (79)</td>
</tr>
</tbody>
</table>

* A given patient may have several risk factors.
† Pelvic surgery category includes cesarean section (n = 4) and normal delivery (n = 2).
‡ Cardiac surgery (n = 2), neurosurgery (n = 3), larynx surgery (n = 2).
§ This category includes coagulation abnormalities, immobilization, recent long journey.
symptomatic and asymptomatic DVT, as well as the proportion of proximal thrombi, were not reported. Interestingly in this study,7 among 33 patients with an indeterminate lung scan but with normal pulmonary angiography, 11 (33%) were found to have DVT on systematic lower limb venography. The study by Kruit et al11 provided slightly more detailed data: 38 of 41 patients (93%) with high-probability lung scans had abnormal venograms, 33% of DVTs were limited to the calf, and only 28% of patients with DVT showed signs or symptoms of thrombosis. These data are consistent with those reported in our study of a much larger group of patients. Finally, in the THÉSÉE study,10 among 612 patients with acute symptomatic PE, 255 patients (42%) had symptoms of DVT and 421 (72%) had DVT diagnosed by venous US or venography. These raw data also are close to those reported in our study, but the exact proportions of patients with and without symptoms who actually had DVT were not reported and, in fact, 70 patients in THÉSÉE had indeterminate lung scans. Furthermore, the use of US in an unspecified proportion of patients may also have underestimated the prevalence of DVT in this population. Thus, our data obtained in 213 patients who had both angiography-proven PE and bilateral lower limb venography are not different from the published literature, but they appear both original and more reliable.

The lower prevalence of DVT diagnosed in patients with pelvic risk factors (50%) is not surprising, as most pelvic veins, the likely source of the venous thrombi responsible for PE in these patients, cannot be visualized by lower limb venography unless the clots reach the iliac veins or vena cava. Therefore, when PE is suspected in this particular population, the diagnostic efficacy of DVT screening is likely to be poor, especially if only compression US of femoral and popliteal veins is performed. On the other hand, in patients with orthopedic risk factors and a clinically suspected PE, such strategies are likely to be much more effective (Table 1).

Our finding that the mean PVO was significantly lower in patients with normal venography than in patients with DVT (Table 3) is more difficult to explain, and only speculative interpretations, such as “smaller venous clots produce less severe PE and are less likely to be seen on venograms,” may be given for this finding. However, one may note that the absolute difference in mean PVO between patients with and without DVT (38% vs 48%) is not wide, and that the range of individual values is similar in both subgroups (Table 3). In our view, the only potential practical implication of these data is that the probability of finding residual DVT is higher in patients with more severe PE. This was confirmed by our comparison between patients with massive (PVO ≥ 50%) and submassive (PVO < 50%) PE, with DVT prevalences of 90.5% and 72.2%, respectively.

The high proportion of patients with both PE and DVT in our study population further confirms that venous thromboembolic disease is indeed one entity,5 and weakens any attempt at differentiating the pathophysiology of venous thromboembolism in patients with so-called isolated PE vs those with isolated DVT.32 Our data also support the view that the presenting symptoms (pulmonary, venous, or both)
should have limited diagnostic and therapeutic implications. However, whether the presence of detectable DVT in patients with acute PE is associated with a higher risk of recurrent PE, leading one to consider IVC interruption, might remain a matter of debate. To the best of our knowledge, this risk has been assessed in only one prospective observational study in which the overall 15-day risk of recurrent PE in 50 patients with both angiography-proven PE and venography-proven proximal DVT was found to be only 4%. It is very close to the risk of PE in the overall population of patients with proximal DVT with or without associated PE. It seems likely, however, that the “very high-risk” patients who will develop a new (and potentially fatal) PE despite anticoagulant treatment belong to this subgroup.

The implications of our findings in routine clinical practice, from both the diagnostic and therapeutic points of view, need specific study. Of course, we no longer perform and would not recommend routine venography in patients with suspected or proven PE. Compression US, despite its limitations, is a useful and safe tool for avoiding invasive procedures in a significant number of patients with suspected venous thromboembolism. However, the development of noninvasive diagnostic tests that could reliably diagnose DVT, whatever its location (such as MRI for the pelvic or calf veins or an extended US technique searching for calf and/or iliofemoral DVT), might make the search for asymptomatic DVT in patients with suspected PE even more efficient.

Finally, our study reliably establishes that a high proportion of patients with PE have detectable venous thrombi, which may not only help in diagnosing venous thromboembolic disease, but also need specific therapeutic measures. For example, the clinical benefit of adding elastic stockings to anticoagulant treatment has been demonstrated in patients with symptomatic proximal DVT. Although a similar benefit has not yet been demonstrated in patients with calf and/or asymptomatic DVT, given the low cost of this measure, it might be considered in most patients with proven PE, whatever the results of compression US.

We demonstrated that the prevalence of residual DVTs that can be diagnosed by lower limb venography in patients with acute PE is higher than was previously thought. These original data constitute a unique and reliable basis for clinicians and researchers designing new diagnostic and therapeutic strategies in various subgroups of patients with suspected or proven acute PE.

### References


### Table 4—Prevalence of DVT in Patients With Acute PE

<table>
<thead>
<tr>
<th>Reference</th>
<th>Diagnosis of PE</th>
<th>No. of Patients</th>
<th>Diagnosis of DVT</th>
<th>Prevalence of DVT, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull et al (1983)</td>
<td>Pulmonary angiography</td>
<td>41</td>
<td>Venography</td>
<td>71</td>
</tr>
<tr>
<td>Quinn et al (1991)</td>
<td>High-probability V/Q lung scan</td>
<td>41</td>
<td>Venography</td>
<td>93</td>
</tr>
<tr>
<td>Turkstra et al (1996)</td>
<td>Pulmonary angiography or high-probability V/Q lung scan</td>
<td>149</td>
<td>Compression US (&quot;from the inguinal canal to the mid-calf&quot;)</td>
<td>29</td>
</tr>
<tr>
<td>Simonneau et al (1997)</td>
<td>Pulmonary angiography, high-probability V/Q lung scan, or indeterminate lung scan</td>
<td>612</td>
<td>Venography or extended compression US</td>
<td>72</td>
</tr>
<tr>
<td>Present study</td>
<td>Pulmonary angiography</td>
<td>213</td>
<td>Venography</td>
<td>82</td>
</tr>
</tbody>
</table>

*V/Q = ventilation/perfusion.*


