Deep Venous Thrombosis Caused by Femoral Venous Catheters in Critically Ill Adult Patients*

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Study objectives: To determine the frequency of and potential risk factors for catheter-related deep venous thrombosis (DVT) in critically ill adult patients.

Design: Prospective, controlled, observational cohort study.

Setting: A mixed medical and surgical ICU in a university hospital.

Patients: All adult patients undergoing femoral vein catheterization.

Interventions: None.

Measurements: ICU diagnosis, underlying disease, demographic data, type of catheter, complications during cannulation, use of anticoagulants, coagulation status, medications infused, and duration of catheterization were recorded. Compression and duplex Doppler ultrasound studies of both femoral veins were performed prior to insertion, at 12 h after insertion, and daily until catheter removal. Follow-up investigation was performed at 24 h and 1 week after removal.

Results: Of 140 cases entered into the study, 124 were evaluated. Fourteen patients developed iliofemoral vein DVTs. Two were clinically obvious. Twelve (9.6%) were line related (uncannulated leg normal) and two (1.6%) occurred only in the uncannulated leg (p = 0.011; relative risk, 6.0; confidence interval, 1.5 to 23.5). Line-related DVT can occur any time from the day after insertion to 1 week after removal. The incidence of catheter-related DVT was unrelated to number of insertion attempts, arterial puncture or hematoma, duration of catheterization, coagulation status, or type of infused medications. No other predisposing or protective factors were identified. Three of the 12 patients with catheter-related DVT died. In no patient was clinical pulmonary embolus suspected.

Conclusion: Although the femoral route is convenient and has potential advantages, the use of femoral lines increases the risk of iliofemoral DVT. Catheter-related DVT may occur as soon as 1 day after cannulation and is usually asymptomatic. This increased risk should be carefully considered when the femoral route of cannulation is chosen. *(CHEST 2000; 117:178–183)*

Key words: catheterization; central venous; complications; critically ill; femoral vein; thrombosis

Abbreviations: DVT = deep venous thrombosis; PT = prothrombin time; PTT = partial thromboplastin time

Central venous catheterization is one of the most commonly used invasive procedures in critically ill patients. The most frequent sites of cannulation are the internal jugular and subclavian veins.1 Complications include arterial puncture with the internal jugular approach (0.1 to 4%) and pneumothorax or hemothorax with the subclavian approach (1 to 5%).1–3 Other possible complications include air embolism, venous thrombosis, thoracic duct laceration, phrenic or recurrent laryngeal nerve damage, and brachial plexus injury.2

Central venous cannulation via the femoral route has several potential advantages. There is no risk of pneumothorax, the site is directly compressible should bleeding occur, and nerve damage is unlikely. More sites of access are available for use in patients requiring multiple cannulae or with restricted access to the veins of the upper extremities. Femoral venous catheters can be inserted with relative ease and have been used successfully in acute resuscitation4,5 and severely burned patients.6 Recent studies in pediatric7 and adult8 critically ill patients have
concluded that the femoral vein is a useful site for central venous cannulation, and these studies quoted few complications.

Earlier reports of catheter-induced deep venous thrombosis (DVT) and other complications have resulted in the restricted use of the femoral route for central venous catheterization. However, because of changes in catheter materials (modern polyurethane catheters are less thrombogenic than polyvinyl and polyethylene catheters) and improved sterile techniques in recent years, interest in femoral catheterization has increased. As a result, the utility of femoral venous catheters and the associated complications in critically ill patients are being re-evaluated.

The aim of this study was to prospectively evaluate the incidence and risk factors for catheter-related DVT associated with the use of femoral catheters in critically ill patients.

Materials and Methods

The study was performed in a 16-bed, mixed medical and surgical ICU at a university teaching hospital. Approval for the study was obtained from the Clinical Research Ethics Committee of the Chinese University of Hong Kong. Informed consent was obtained from a senior relative when the patient’s condition precluded provision of his or her own consent. All adult patients undergoing femoral-route central venous catheterization between January 1996 and February 1998 were recruited for the study. The following patients were excluded from the study: patients with infection or inflammation at the site of insertion; existing or previous DVT; recent pelvic or abdominal trauma; lower extremity ischemia; documented hypercoagulable state (protein C or S deficiency, antithrombin deficiency, or lupus anticoagulant); prior femoral catheterization; and survival < 24 h after catheter insertion. Attempts were made not to cannulate the contralateral femoral vein; where this was unavoidable, the patient was withdrawn from the study.

Catheters were inserted by intensive care specialists, intensive care trainees, or senior anaesthesiology trainees. All catheters were inserted using the Seldinger technique. The skin was prepared with an iodine solution and chlorhexidine in alcohol solution. Strict aseptic conditions were followed, with the operator wearing mask, gloves, and a surgical gown. Triple-lumen catheters, introducer sheaths, and dialysis catheters were included in the study. After insertion, catheters were sutured to the skin and covered with gauze and an occlusive dressing.

At catheter insertion the following were recorded: Acute Physiology and Chronic Health Evaluation II score; patient age; weight; diagnosis; catheter position; catheter type, size, and length; number of attempts at insertion; arterial puncture; hematoma; and local bleeding. During the catheterization period, local complications monitored included presence of leg swelling/discoloration and insertion site infection (erythema or purulent discharge). Catheter tips were aseptically removed and cultured by the roll-plate method. Colonization was considered present if a growth of ≥ 15 colony-forming units was reported. Catheter-related bacteremia was considered present if the same organism was grown from the blood at a peripheral site at the time of catheter removal. The following were recorded daily: prothrombin time (PT) and partial thromboplastin time (PTT); platelet count; drugs infused through the femoral line; and systemic drug therapy. Routine DVT prophylaxis is not practiced in the ICU. The use of anticoagulants in special circumstances or for any other purpose, along with the use of other drugs, was recorded.

Investigation and diagnosis of DVT was made by ultrasound examination. Ultrasound examination was performed with the patient in the supine position before catheter insertion, within 12 h after insertion, and daily until discharge. A follow-up ultrasound examination was performed at 24 h and 1 week after catheter removal. The deep venous systems of both lower extremities were examined, from the external iliac veins proximally to the popliteal veins distally. The veins were evaluated in the transverse and longitudinal planes using the compression technique of Cronan et al., supplemented with duplex and color Doppler capability. DVT was diagnosed when there was visualization of thrombus, noncompressibility of the vein, no spontaneous Doppler flow, lack of phasicity and augmentation, and Doppler and color spectral flow void. The site of DVT was recorded. Scans were performed with a diagnostic ultrasound system (Briel and Kaer Medical; Gentofte, Denmark), using a high-resolution 5-MHz curved linear array probe. In each patient, the uncannulated contralateral femoral vein served as a control. All examinations were recorded and reviewed by a radiologist who was unaware of the patient’s state of coagulation. Because the catheter is usually clearly visible when present, only those investigations performed after removal of the catheter could be adequately blinded.

A power analysis indicated that approximately 140 patients would be required to show a difference at a 5% significance level with 80% power, assuming an incidence of 5% (0 to 10%) in the control leg and 15% (10 to 20%) in the cannulated leg. Results are presented as mean (SD) or median (range), as appropriate. The Student’s t test, χ² test, and Fisher’s Exact Test were used where appropriate. A p value of < 0.05 was considered significant.

Results

Over a 25-month period, 140 patients were entered into the study. Sixteen patients were withdrawn after entry into the study: 1 patient was found to be lupus anticoagulant–positive (this patient developed a line-related DVT); 6 patients survived < 24 h after insertion of the femoral catheter; 3 patients had attempted cannulation of the contralateral vein; and 6 patients required cannulation of the contralateral femoral vein before the follow-up period was complete. Thus, 124 patients were evaluated. Twelve patients developed an iliofemoral DVT on the same side as the femoral catheter. Two patients developed an iliofemoral DVT in the control leg (p = 0.011; relative risk, 6.0; confidence interval, 1.5 to 23.5). All catheters were used for fluid or drug therapy; some were also used for parenteral nutrition. The right femoral vein was successfully cannulated in 105 patients and the left in 19 patients. The incidence of catheter-related DVT on the right side (9/105) and left side (3/19) was similar (p = 0.3). Demographic data and catheter characteristics are presented in Table 1. The type, diameter, and length of catheter used was not standardized in order to
reflect the normal clinical setting. Of the 124 patients assessed, cannulation was performed with triple-lumen catheters in 113 patients, with introducer sheaths in 7 patients, and with dialysis catheters in 4 patients. All DVTs occurred in patients cannulated with triple-lumen catheters. Neither increased length nor diameter appeared to increase the rate of thrombosis (Table 1). Heparin impregnation of catheters did not appear to protect against thrombosis. While the majority of catheters used were heparin bonded, no increase in the rate of thrombosis was seen in nonbonded lines (Table 1).

Other possible factors that might have predisposed patients to the development of DVT, such as the infusion of hypertonic or irritant medications through the catheter, were not identified. The following were individually assessed: mannitol, thiopentone, β-lactam antibiotics, erythromycin, metronidazole, potassium, and anticoagulants.

General catheter-related complications are presented in Table 2. All superficial hematomas or hemorrhage responded to local pressure dressing. No surgical intervention or transfusion was required for therapy. Similarly, no serious or long-term sequelae resulted from inadvertent arterial puncture; all cases were successfully treated with digital pressure followed by a pressure dressing. Catheter colonization occurred in nine patients (7%). Colonizing organisms were Acinetobacter baumannii (in two patients), Pseudomonas aeruginosa (one patient), Candida albicans (one patient), and Staphylococcus epidermidis (eight patients). Three additional cases (2.4%) were associated with bacteremia/fungemia involving C albicans (one patient) and S epidermidis (two patients). All cases responded to line removal and appropriate antibiotic therapy. No patient exhibited clinical evidence suggesting pulmonary embolism. The causes of death in the two nonsurvivors with confirmed iliofemoral DVT were fulminant septic shock and multiple organ dysfunction in one patient and respiratory failure from ARDS in the other patient.

### Discussion

This prospective study demonstrates a consistent and clinically important increase in iliofemoral DVT

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**Table 1—Patient Demographics and Catheter Characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients Without Catheter-Related DVT (n = 112)</th>
<th>Patients With Catheter-Related DVT (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>53 (18)</td>
<td>54 (15)</td>
</tr>
<tr>
<td>Female sex, No. (%)</td>
<td>41 (37)</td>
<td>6 (50)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>66 (11)</td>
<td>65 (17)</td>
</tr>
<tr>
<td>APACHE II score, median (range)</td>
<td>21 (9–38)</td>
<td>20 (12–29)</td>
</tr>
<tr>
<td>General surgical category, No. (%)</td>
<td>28 (25)</td>
<td>2 (17)</td>
</tr>
<tr>
<td>Neurosurgical category, No. (%)</td>
<td>15 (13)</td>
<td>—</td>
</tr>
<tr>
<td>Medical category, No. (%)</td>
<td>57 (51)</td>
<td>9 (75)</td>
</tr>
<tr>
<td>Trauma category, No. (%)</td>
<td>9 (8)</td>
<td>1 (8)</td>
</tr>
<tr>
<td>Presence of malignancy, No. (%)</td>
<td>3 (2)</td>
<td>—</td>
</tr>
<tr>
<td>Coagulation status†</td>
<td>13 (12)</td>
<td>1 (8)</td>
</tr>
<tr>
<td>PT, s</td>
<td>Preinsertion 16 (6)</td>
<td>14 (3)</td>
</tr>
<tr>
<td>At 24 h</td>
<td>17 (6)</td>
<td>15 (3)</td>
</tr>
<tr>
<td>PTT, s</td>
<td>Preinsertion 41 (14)</td>
<td>37 (10)</td>
</tr>
<tr>
<td>At 24 h</td>
<td>44 (15)</td>
<td>39 (7)</td>
</tr>
<tr>
<td>Platelet count, × 10^9/mL</td>
<td>Preinsertion 174 (112)</td>
<td>146 (103)</td>
</tr>
<tr>
<td>At 24 h</td>
<td>170 (129)</td>
<td>144 (116)</td>
</tr>
<tr>
<td>Line characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length, cm</td>
<td>24 (11)</td>
<td>27 (10)</td>
</tr>
<tr>
<td>Size, F</td>
<td>7 (1)</td>
<td>7 (0)</td>
</tr>
<tr>
<td>Heparin-coated, No. (%)</td>
<td>90 (80)</td>
<td>9 (75)</td>
</tr>
<tr>
<td>Days in situ</td>
<td>5 (3)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Median (range)</td>
<td>6 (2–16)</td>
<td>4 (2–7)</td>
</tr>
</tbody>
</table>

*Data expressed as mean (SD) unless otherwise indicated. There were no significant differences between patients with and without catheter-related DVT; APACHE = Acute Physiology and Chronic Health Evaluation.
†Coagulation was assessed immediately before insertion and 24 h after insertion.
following the use of femoral venous catheters. Patients with femoral lines in situ can expect to have, on average, a sixfold increased risk of iliofemoral DVT. Despite this being the largest study to date, the confidence intervals are wide and the risk may be as low as twofold or as high as 20-fold the baseline risk of iliofemoral DVT in noncatheterized limbs. Other studies performed to specifically examine iliofemoral catheter-related DVT have reached varying conclusions regarding the increased risk from catheterization.13,14,21,22 Using venous duplex ultrasound, Meredith et al22 identified a 12% incidence of line-related iliofemoral DVT (vs 4% in control limb) in acute trauma patients following the use of 8.5F catheters for resuscitation, and concluded that routine or indiscriminate use of femoral lines should be reconsidered. Trottier et al,21 also using duplex ultrasound, showed a proximal lower limb (not clearly defined iliofemoral region) DVT rate of 25% (incidence in control limbs, 0%) following the use of femoral triple-lumen and dialysis catheters. They concluded that physicians should be aware of the risk of the femoral route and consider ultrasound screening of the lower limb after catheter removal. Durbec et al14 found a 6.6% incidence of iliofemoral DVT (3% in control limbs) using phlebography and concluded, in contrast to others, that this incidence was acceptable. In a second study, Durbec et al13 found an incidence of iliofemoral thrombosis of 8.5%, and again concluded that this was acceptable. The studies did examine slightly different patient groups and used different techniques of detecting DVT; however, the results presented above appear remarkably consistent. These studies, if combined, would produce an increased risk of approximately seven times the expected baseline risk, similar to that found in our study. In keeping with the results of other studies,13,22 the incidence of iliofemoral DVT in the control limb was low. The few studies that have examined the incidence of iliofemoral DVT in intensive care patients indicate that the incidence of DVT in the iliofemoral region, in the absence of any attempt at femoral vein catheterization of either leg, is about 2% (range, 0 to 4%).14,21,23 The attributable increase in risk can therefore be expected to be in the region of 10 to 15%. This is a risk of clinical significance and should be carefully considered whenever femoral catheterization is indicated. The lack of clinical features of DVT in these patients—only 2 of 12 patients had evidence of leg swelling (Table 2)—may produce a false sense of security and makes knowledge of the risk of this complication more important.

A unique aspect of this study is that patients were examined prior to catheter insertion and at least daily while the catheter was in situ. Absence of DVT prior to catheterization was thus documented, and the postinsertion time at which the DVT developed could be clearly demonstrated. Although it has been previously suggested that there may be a safe duration of catheterization,13,21 our data clearly show that catheter-related DVT may occur at any time, from day 1 to 1 week after removal of the catheter (Fig 1), and no “safe” period for catheterization exists.

In accordance with preexisting intensive care protocols at the time of the study, routine DVT prophylaxis was not used. This is because the incidence of DVT in Chinese patients has been reported to be relatively low.24,25 The results of this study, without prophylaxis, remain similar to those found in other studies in which either some or all patients received DVT prophylaxis.13,14,21,22 The study design does not permit an answer to the important question of whether the use of optimal DVT prophylaxis will reduce the overall risk of catheter-related DVT. Autoanticoagulation, commonly seen in critically ill

Table 2—Complications of Femoral Venous Catheterization*

<table>
<thead>
<tr>
<th>Complications</th>
<th>Patients Without DVT</th>
<th>Patients With DVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion attempts, No.</td>
<td>1.6 (0.9)</td>
<td>1.8 (0.6)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>1 (1–4)</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td>Median (range)</td>
<td>9 (8)</td>
<td>11 (8)</td>
</tr>
<tr>
<td>Hematoma, No. (%)</td>
<td>8 (7)</td>
<td>11 (8)</td>
</tr>
<tr>
<td>Catheter colonization, No. (%)</td>
<td>2 (1.7)</td>
<td>2 (1.7)</td>
</tr>
<tr>
<td>Arterial puncture, No. (%)</td>
<td>8 (7)</td>
<td>11 (8)</td>
</tr>
<tr>
<td>Leg swelling, No. (%)</td>
<td>1 (1)</td>
<td>2 (16)</td>
</tr>
<tr>
<td>Clinical pulmonary embolism</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*There were no significant differences between patients with and without catheter-related DVT.

Figure 1. Time of onset of DVT in critically ill patients after insertion of the femoral catheter. Day 1 and Week 1 refer to the diagnosis of DVT at 24 h after removal of the catheter and at 1 week of follow-up, respectively.
patients, might have been expected to protect patients against DVT. Surprisingly, the PT and PTT did not differ in those patients who developed line-related DVT vs those who did not, suggesting that anticoagulation is not significantly protective (Table 1).

The major life-threatening complication of DVT is pulmonary embolism. The frequency of pulmonary embolism following catheter-related DVT is unknown. No recent study of catheter-related DVT following the use of femoral lines has systematically searched for evidence of pulmonary embolism. Recent studies (representing a total of 743 patients) evaluating the complications and utility of femoral lines have reported no cases of clinically evident pulmonary embolism.4,8,14,21,22 Although this is not strong evidence of the absence of pulmonary embolism, the likelihood of a high incidence of clinically important pulmonary embolus following femoral catheterization is low.

Compression and color duplex Doppler ultrasonography was chosen as the diagnostic modality for this study because it allows repeat examinations in the ICU, it is safe, and it has an acceptably high sensitivity and specificity for detecting iliofemoral DVT.26 Distal and calf vein DVT was not assessed, as it is unlikely that distal and calf vein DVT could be caused by the presence of a femoral catheter. A recent study confirmed that distal vein thrombosis occurs at similar rates, regardless of the site of catheter insertion,14 and that the occurrence of distal thrombosis is not associated with femoral vein cannulation.

A disappointing aspect of the study was the inability to identify factors that might be associated with the occurrence of catheter-related DVT. Reasons for this failure may include the additive nature of risk factors for DVT, the small number of patients who developed DVT, or a failure to document and record important potential factors. Therefore, on the basis of this study, no recommendations can be made that might help identify high-risk patients, improve technique, or guide catheter choice.

When clinicians are deciding whether to use the thoracic or femoral route, the following important issues need to be considered. Insertion complications such as arterial puncture (0.1 to 4%) and pneumothorax or hemothorax (1 to 5%) associated with the thoracic route should be weighed against the risk of arterial puncture (5%) when the femoral route is used (in the event of bleeding, the femoral artery is readily compressible). The risk of infection is thought to be greater when the femoral route is used, but there are no good clinical data in intensive care patients supporting this view; the one study comparing catheters in the radial and femoral artery showed no difference in infectious complications.27

The risk of catheter-related DVT in thoracic veins (approximately 10%)28–30 is similar to that found in femoral veins in this study. The risk of pulmonary embolus as a result of DVT of the proximal lower limbs is thought to be higher than from thoracic vessel DVT31,32; however, we can find no good evidence to support this in catheter-associated DVT or critically ill patients. As discussed above, the incidence of clinically observed pulmonary embolism in patients undergoing femoral catheterization is low. The decision must, therefore, be one of clinical judgment, depending on the benefit-risk ratio in individual circumstances.

In conclusion, there is a sixfold increased risk of iliofemoral DVT following femoral vein catheterization. Catheter-related DVT occurrence is not related to the duration of catheterization, and it can occur at any time during the course of catheterization or after removal. There are currently no identified factors that predict increased risk for developing catheter-related DVT. In clinical practice, clinicians need to be aware of an increased risk of iliofemoral DVT, but the femoral route of venous access remains an important alternative to the upper extremities.

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