Complications of Femoral and Subclavian Venous Catheterization in Critically Ill Patients
A Randomized Controlled Trial

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Context Whether venous catheterization at the femoral site is associated with an increased risk of complications compared with that at the subclavian site is debated.

Objective To compare mechanical, infectious, and thrombotic complications of femoral and subclavian venous catheterization.

Design and Setting Concealed, randomized controlled clinical trial conducted between December 1997 and July 2000 at 8 intensive care units (ICUs) in France.

Patients Two hundred eighty-nine adult patients receiving a first central venous catheter.

Interventions Patients were randomly assigned to undergo central venous catheterization at the femoral site (n=145) or subclavian site (n=144).

Main Outcome Measures Rate and severity of mechanical, infectious, and thrombotic complications, compared by catheterization site in 289, 270, and 223 patients, respectively.

Results Femoral catheterization was associated with a higher incidence rate of overall infectious complications (19.8% vs 4.5%; $P<.001$; incidence density of 20 vs 3.7 per 1000 catheter-days) and of major infectious complications (clinical sepsis with or without bloodstream infection, 4.4% vs 1.5%; $P=.07$; incidence density of 4.5 vs 1.2 per 1000 catheter-days), as well as of overall thrombotic complications (21.5% vs 1.9%; $P<.001$) and complete thrombosis of the vessel (6% vs 0%; $P=.01$); rates of overall and major mechanical complications were similar between the 2 groups (17.3% vs 18.8 %; $P=.74$ and 1.4% vs 2.8%; $P=.44$, respectively). Risk factors for mechanical complications were duration of insertion (odds ratio [OR], 1.05; 95% confidence interval [CI], 1.03-1.08 per additional minute; $P<.001$); insertion in 2 of the centers (OR, 4.52; 95% CI, 1.81-11.23; $P=.001$); and insertion during the night (OR, 2.06; 95% CI, 1.04-4.08; $P=.03$). The only factor associated with infectious complications was femoral catheterization (hazard ratio [HR], 4.83; 95% CI, 1.96-11.93; $P<.001$); antibiotic administration via the catheter decreased risk of infectious complications (HR, 0.41; 95% CI, 0.18-0.93; $P=.03$). Femoral catheterization was the only risk factor for thrombotic complications (OR, 14.42; 95% CI, 3.33-62.57; $P<.001$).

Conclusion Femoral venous catheterization is associated with a greater risk of infectious and thrombotic complications than subclavian catheterization in ICU patients.
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Central venous catheterization is often necessary to treat critically ill patients hospitalized in intensive care units (ICUs). However, this procedure can lead to serious and sometimes life-threatening complications, whether mechanical, infectious, or thrombotic. The choice of insertion site can influence the incidence and type of such complications.

Major femoral or retroperitoneal hematoma is the most frequent major mechanical complication of femoral venous catheterization, occurring in up to 1.3% of cases,[1,2] whereas pneumothorax is the most frequent major complication of subclavian venous catheterization, occurring in 1.5% to 2.3% of cases.[3,4] Reported rates of catheter-related thrombosis range from 6.6% to 25% with femoral catheterization[5-7] and from 10% to 50% with subclavian catheterization.[8,9] These differences may be related to use of various diagnostic ap-

proaches (eg, venography, compression sonography, duplex Doppler ultrasonography with or without color flow Doppler imaging), nonuniform definitions of thrombosis, and different timing of examination (ie, before or after catheter removal). To our knowledge, no study has compared the rates of thrombotic complications using the same technique and definitions for femoral vs subclavian catheter insertion.

In contrast, subclavian catheterization has been associated with a lower rate of infection compared with femoral catheterization[10,11] and, therefore, has been recommended by consensus reports and experts.[12,13] However, this is not supported by strong evidence from randomized studies. Observational studies may be biased due to inclusion of patients who underwent emergency catheterization. Alternatively, a different case-mix may have led to overestimation of the risk of infection at the femoral site. Several recent case series have suggested that the rate of catheter-related infections at the femoral site may be acceptable[1,14,15] and debate continues concerning the relative risk of complications associated with femoral catheterization compared with at other sites.

In the absence of contraindication to catheterization at either site, selection of the subclavian or femoral site is based on individual patient factors and physician experience and preference rather than on strong evidence from the literature. We therefore conducted a multicenter, prospective, concealed, randomized controlled trial in ICU patients to compare the rates of mechanical, infectious, and thrombotic complications associated with femoral vs subclavian venous catheterization and to identify the risk factors associated with these complications.

METHODS
Enrollment

The study was conducted between December 1997 and July 2000 in 8 ICUs. Four ICUs were in university-affiliated hospitals and the remaining 4 were in general hospitals. We screened patients consecutively admitted to the ICUs

to identify patients older than 18 years who were expected to require central venous catheterization. Only patients who were undergoing their first central venous catheterization during the index ICU stay were eligible. Exclusion criteria were presence of a central venous catheter at admission, central venous catheterization within 15 days prior to admission, emergency catheterization for a life-threatening situation, a moribund state, contraindication to use of subclavian or femoral catheterization due to major blood coagulation disorders (ie, platelet count $<50\times10^3/\mu L$, prothrombin time >1.6 times of the normal range, partial thromboplastin time >2 times of the normal range, or therapeutic anticoagulation), severe hypoxemia (PaO_2/fraction of inspired oxygen <150 mm Hg), anatomic defect precluding catheterization at either site, skin lesions or recent surgery at either site, phlebitis, body mass index of more than 35 kg/m^2 for men or more than 30 kg/m^2 for women, and previous randomization in the present or another trial. The study was approved by the ethics committee of Hôpital de Poissy/St-Germain-en-Laye, St-Germain-en-Laye, France, and written informed consent was obtained from the patients or their proxies.

Randomization

Patients were randomly assigned to undergo insertion of a central venous catheter at either the subclavian site or the femoral site. Randomization was performed in blocks of 6, with stratification according to center and number of lumens, by means of a computer-generated random-numbers table. The trial was concealed in that the site of insertion was given by telephone to the investigators from the central randomization center. All caregivers and other research personnel were blinded to the randomization schedule and the block size.

Insertion and Maintenance of the Catheters

A 15- or 16-cm-long polyurethane standard central venous catheter was

inserted into the designated site by a staff physician or supervised resident physician. Physicians were allowed to switch from one side to the other if the first attempt was unsuccessful. Maximal sterile-barrier precautions were taken, including use of large sterile drapes, surgical antiseptic hand wash, and sterile gown, gloves, mask, and cap. At the time of catheter insertion and at each dressing change, the insertion site was cleaned with a disinfectant solution (povidone-iodine or chlorhexidine or iodine tincture) according to center preference. All dressings were semipermeable transparent dressings (Opsite IV 3000, Smith & Nephew, Hull, England), which were changed immediately if the dressing was contaminated; otherwise, they were changed routinely according to center preference (every 1-6 days). The catheters were used for any purpose, including administration of intravenous fluids, medications, total parenteral nutrition, and blood products. Catheters were removed at the discretion of the ICU team when they were no longer needed or if an adverse event occurred (ie, malfunction, suspicion of catheter-related infection, or thrombosis).

Definitions

Catheter-Related Mechanical Complications. A detailed list of catheter-related mechanical complications was included in the case report forms (eg, arterial puncture, pneumothorax, hemothorax or mediastinal hematoma, misplacement of the catheter tip, hematoma or bleeding, air embolism). Mechanical complications were recorded from catheter insertion to removal. Catheter-related mechanical complications requiring a specific therapeutic procedure (eg, pneumothorax necessitating chest tube insertion or hemorrhage requiring blood transfusion or surgical procedure) were defined as major mechanical complications.

Catheter-Related Infections. Catheters tips were cultured in all centers using a simplified technique of quantitative broth dilution culture.[16] When

catheter-related infection was suspected, 1 or more peripheral blood samples were collected for culture before or within 48 hours after catheter removal. When the catheter tip culture was positive, 2 investigators (C.B.-B. and G.N.) blinded to the site of catheter insertion reviewed the case report form and medical chart to classify catheters, using previously described clinical and bacteriological data,[17] into 1 of the following categories: (1) catheter contamination (<1000 colony-forming units/mL and no catheter-related clinical sepsis); (2) catheter colonization (≥1000 colony-forming units/mL and no catheter-related clinical sepsis); (3) probable catheter-related clinical sepsis without bloodstream infection; (4) catheter-related clinical sepsis with bloodstream infection; and (5) discrimination between categories 2 and 3 not possible. Categories 2, 3, 4, and 5 were collectively considered catheter-related infectious complications. Categories 3 and 4 were considered major catheter-related infectious complications.

Catheter-Related Thrombosis. Thrombotic events of the catheterized vessel were assessed by systematic compression sonography and duplex Doppler ultrasonography performed within 4 days after catheter removal. Partial thrombosis was assumed when a mural thrombus was observed in the vessel lumen and normal venous flow was recorded by duplex Doppler ultrasonography. Fibrin sleeves were not considered thrombosis. Complete thrombosis was assumed when a thrombus was observed in a noncompressible vein and no venous flow could be detected by duplex Doppler ultrasonography. Thrombosis was considered to be catheter-related when a partial or complete thrombus was found in the subclavian or axillary veins for subclavian catheters and in the femoral or iliac veins for femoral catheters. Major catheter-related thrombosis was defined as complete thrombosis of 1 of these vessels.

End Points

For each type of complication (mechanical, infectious, and thrombotic), the primary end point was occurrence of a catheter-related complication. The secondary end point was occurrence of a major mechanical, infectious, or thrombotic complication.

Statistical Analysis

Estimation of the study sample size was based on the expected difference in colonization rate of femoral vs subclavian catheters. From previous reports,[10,18] we estimated that 7.5% of the subclavian catheters and 20% of the femoral catheters would be colonized. Randomly assigning 133 patients to each catheter group would allow detection of this difference in colonization rate with 80% power and a 2-tailed significance level of .05. Assuming that 10% of the catheters would not be cultured, we planned to include 290 patients in the study. No interim analysis was performed. All patients were analyzed in the group to which they were randomly assigned, according to the intention-to-treat principle.

Data are presented as mean (SD). Duration of catheterization and ICU length of stay before catheterization are reported as median (interquartile range [IQR]). We compared means using the t test or the Wilcoxon rank-sum test and compared proportions using the χ^2 test or the Fisher exact test. All P values are based on 2-tailed tests of significance. The proportions of catheters free of infectious complications were compared between the subclavian and femoral sites as a function of catheter duration, using a log-rank test.

Variables associated with each complication were analyzed by bivariate and multivariate analysis. For mechanical and thrombotic complications, a stepwise logistic regression analysis was performed using the complication as the dependent variable and various parameters as the independent variables (**Box**). For infectious complications, a

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Box. Variables Entered in Bivariate and Multivariate Analyses[*]

Variables Entered in the 3 Models

Age, sex, body mass index (BMI), *type of admission* (medical or surgical [surgical procedure within 7 days before or after admission to intensive care unit {ICU}]), *Simplified Acute Physiologic Score II on admission,*[19] *Organ Dysfunction and/or Infection score at catheter insertion,*[20] *site of insertion, duration (in days) of catheterization* (day of withdrawal – day of insertion + 1), *center number*

Variables Added to the Mechanical Complications Model

Operator experience (senior [>6 months of ICU practice] or resident), *duration of insertion* (from first skin puncture to end of catheter introduction, in minutes), *insertion during the night* (6 PM-8 AM), use of preventive anticoagulation at catheter insertion, *use of anticoagulation agents during catheterization* (preventive or curative)

Variables Added to the Infectious Complications Model

Number of catheter lumens, immunosuppression status, *type of skin antisepsis*, frequency of scheduled dressing, *use of catheter for administration of antibiotics*, use of catheter for administration of blood products, *use of catheter for administration of parenteral nutrition*, use of catheter for blood drawing, use of catheter during surgical or resuscitation procedures, withdrawal of catheter after ICU discharge, partial or complete catheter-associated thrombosis

Variables Added to the Thrombotic Complications Model

Number of catheter lumens, use of catheter for administration of blood products or parenteral nutrition, *use of anticoagulation agents during catheterization* (none, preventive, or curative), immunosuppression status, use of catheter for resuscitation procedures, use of catheter for blood drawing, *catheter-related colonization or clinical sepsis or bloodstream infection*

[*]The italicized variables (*P*<.20 in the bivariate analysis) were entered into the multivariate analysis.
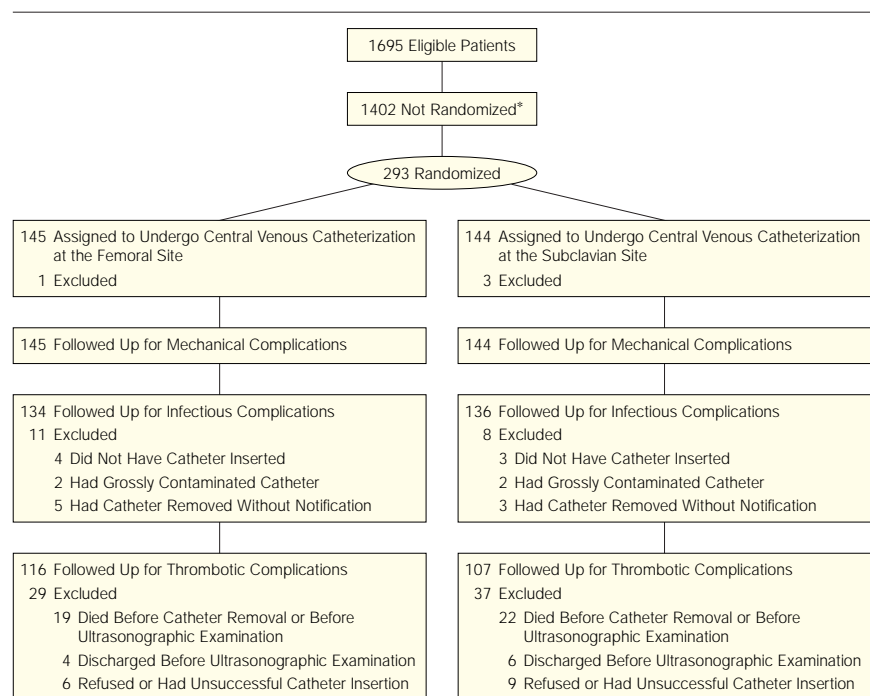
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stepwise Cox proportional hazards model was used. Regression parameters and corresponding hazard ratios (HRs) or odds ratios (ORs) were estimated using the maximum likelihood method. All variables were tested for possible interactions. A significance level of .20 or less was required to enter a variable into the multivariate models, and a significance level of .10 or less was required for a variable to remain in the models. The Hosmer-Lemeshow statistic and/or the likelihood ratio test (both presented as χ^2 values) were used to test goodness-of-fit in selected models. Residuals plots were used to investigate the lack of fit in models. Variables were considered significant at $P<.05$. All computations were performed with SAS software, version 8.0 (SAS Institute Inc, Cary, NC).

RESULTS
Patient and Catheter Characteristics

The 8 ICUs participated in the study for a mean duration of 25 months (range, 9-32 months), during which 5759 patients were admitted. Among them, 1695 patients required a central venous catheter (**FIGURE**). Two hundred ninety-three patients (17.3%) were randomized. Four patients (1 in the femoral group and 3 in the subclavian group) were excluded after randomization because catheterization was not performed (including 1 patient who died between randomization and insertion, 1 patient for whom a senior physician decided after randomization that a central venous catheter was unnecessary, and 2 patients for whom exclusion criteria were discovered after randomization and before catheter insertion). The total number of analyzed patients varied according to each of the 3 complication rate analyses. Of the 289 patients in whom a catheterization was attempted and evaluated for mechanical complications, 270 (93.4%) had their catheter tip cultured and were subsequently evaluated for infectious complications, and 223 (77.2%) were evaluated for thrombotic complications by ultrasonography.

Figure. Flow of Patients Through the Trial

Asterisk indicates that patients were not randomized because of presence of exclusion criteria or refusal of participation by the patient or proxy.

Baseline characteristics were similar in the 2 groups for each of the complication types (**TABLE 1**), except for male to female ratio in patients evaluated for thrombotic complications. The 2 groups were also similar for all catheterization characteristics, except for duration of catheterization (**TABLE 2**), which was significantly longer in the subclavian group (mean, 11.0 vs 9.3 days [$P=.01$]; total, 1534 vs 1335 catheter-days).

Catheter-Related Complications

Mechanical Complications. Catheter-related mechanical complications were assessed in 289 patients, including patients with unsuccessful catheter insertion (n=7). Mechanical complications occurred in 25 (17.3%) of the 145 patients with femoral catheterization and 27 (18.8%) of the 144 patients with subclavian catheterization ($P=.74$). Complications were predominantly arterial puncture (n=13 in the femoral group vs n=7 in the subclavian group), minor bleeding (n=7 vs n=5), and

minor hematoma (n=4 vs n=3); 2 major hematomas occurred in the femoral group, and 8 misplacements into the internal jugular vein and 4 pneumothoraces occurred in the subclavian group. In 1 patient, both a minor and a major complication occurred. There were 2 major mechanical complications in the femoral group (1.4%) and 4 in the subclavian group (2.8%; $P=.44$).

Factors significantly associated with occurrence of a mechanical complication in bivariate analysis were catheter insertion during the night, duration of catheter insertion, duration of catheter placement, and catheter insertion at 2 of the participating centers. In the multivariate logistic regression model (Hosmer-Lemeshow $\chi^2_8=10.3$; likelihood ratio test $\chi^2_3=31.6$), the following risk factors were associated with occurrence of a mechanical complication: duration of catheter insertion (per additional minute, OR, 1.05; 95% confidence interval [CI], 1.03-1.08; $P<.001$); catheter insertion at 2 of the participating centers (OR, 4.52; 95% CI,

1.81-11.23; $P=.001$); and catheter insertion during the night (OR, 2.06; 95% CI, 1.04-4.08; $P=.03$).

Infectious Complications. Infectious complications were analyzed in 270 (93.4%) of the 289 patients randomized (**TABLE 3**). Among the 19 patients with no catheter tip culture, 7

catheters could not be inserted, 4 were grossly contaminated during removal, and 8 were removed without notification of the investigator. Catheters were removed because of suspicion of catheter-related sepsis in 31 patients in the femoral group and 37 patients in the subclavian group ($P=.44$). Catheter-

related infectious complications were recorded in 27 (19.8%) of the femoral catheters and 6 (4.5%) of the subclavian catheters ($P<.001$ by log-rank test). The incidence densities of infectious complications were 20 per 1000 femoral catheter-days and 3.7 per 1000 subclavian catheter-days. There were 6

Table 1. Patient Characteristics*

Characteristics	All Patients (n = 289)		Patients With Catheter Culture (n = 270)		Patients With Ultrasonographic Examination (n = 223)	
	Femoral Group (n = 145)	Subclavian Group (n = 144)	Femoral Group (n = 134)	Subclavian Group (n = 136)	Femoral Group (n = 116)	Subclavian Group (n = 107)
Age, mean (SD), y	60.1 (17.3)	61.9 (17)	59.7 (17)	61.9 (16.8)	58.4 (17.5)	60.4 (15.7)
Male, No. (%)	102 (70)	90 (63)	94 (70)	85 (62)	83 (72)†	62 (58)†
Body mass index, mean (SD), kg/m²	23.6 (4.0)	23.8 (4.2)	23.7 (4.0)	23.9 (4.2)	23.8 (4.1)	23.6 (4.3)
Immunosuppression, No. (%)	13 (9)	9 (6)	13 (10)	9 (7)	10 (9)‡	4 (4)‡
SAPS II, mean (SD)	40.1 (16.7)	40.1 (17.9)	39.2 (16.2)	40.2 (18.0)	37.5 (14.8)	40.0 (18.1)
Type of admission, No. (%)						
Medical	99 (68)	108 (75)	93 (69)	101 (74)	78 (67)	81 (77)
Surgical	46 (34)	36 (25)	41 (31)	35 (26)	38 (33)	26 (23)
Mechanical ventilation, No. (%)	112 (77)	109 (76)	101 (75)	105 (77)	84 (72)	82 (78)
ODIN score, mean (SD)	2.0 (1.3)	2.0 (1.2)	2.0 (1.2)	2.0 (1.2)	1.8 (1.2)	2.0 (1.2)
Time between intensive care unit admission and insertion, median (interquartile range), d	1 (0-3)	1 (0-3)	1 (0-3)	1 (0-3)	1 (0-3)	1 (0-3)

*$P>.20$ for femoral vs subclavian catheterization groups, unless otherwise specified. SAPS II indicates Simplified Acute Physiologic Score II[19]; ODIN, Organ Dysfunction and/or Infection.[20]
†$P = .03$.
‡$P = .13$.

Table 2. Characteristics Associated With Central Venous Catheter Insertion*

Characteristics	All Patients (n = 289)		Patients With Catheter Culture (n = 270)		Patients With Ultrasonographic Examination (n = 223)	
	Femoral Group (n = 145)	Subclavian Group (n = 144)	Femoral Group (n = 134)	Subclavian Group (n = 136)	Femoral Group (n = 116)	Subclavian Group (n = 107)
Lumens, No. of patients						
1	26	28	24	28	22	25
2	69	66	65	60	57	45
3	50	50	45	48	37	37
Catheter inserted by a senior physician, No. (%)	77 (53)	84 (58)	68 (51)†	83 (61)†	59 (51)‡	64 (60)‡
Use of povidone-iodine antisepsis, No. (%)	125 (86)	122 (85)	115 (86)	115 (85)	101 (87)	89 (83)
Use of catheter for administration of, No. (%)						
Antibiotics	89 (61)	92 (64)	80 (62)	87 (64)	65 (56)	69 (64)
Blood products	30 (21)	26 (18)	28 (21)	24 (18)	23 (20)	18 (17)
Parenteral nutrition	88 (61)	91 (63)	83 (62)	89 (65)	71 (61)	70 (65)
Prophylactic anticoagulation, No. (%)	123 (85)	123 (85)	116 (87)	120 (88)	101 (87)	97 (91)
Duration of catheter placement, mean (SD), d	9.3 (6.2)§	11.0 (6.3)§	9.4 (6.2)‖	11.1 (6.3)‖	9.6 (6.3)¶	11.3 (6.4)¶
Time between catheter removal and ultrasonographic study, mean (SD), d	NA	NA	NA	NA	2.6 (1.5)	2.8 (1.7)

*$P>.20$ for femoral vs subclavian catheterization groups, unless otherwise noted. NA indicates not applicable.
†$P = .09$.
‡$P = .18$.
§$P = .01$.
‖$P = .009$.
¶$P = .02$.

major catheter-related infectious complications in the femoral group (4.4%) and 2 in the subclavian group (1.5%; $P = .07$ by log-rank test). The incidence densities of major infectious complications were 4.5 per 1000 femoral catheter-days and 1.2 per 1000 subclavian catheter-days. Significant factors associated with occurrence of an infectious complication in bivariate analysis included 3 risk factors: insertion at femoral site, high Organ Dysfunction and/or Infection score at admission, and insertion at 2 centers; and 2 protective factors: use of the catheter for systemic administration of antibiotics and insertion at 2 centers. In a Cox model (likelihood ratio test $\chi^2_2 = 22.1$), insertion at the femoral site (HR, 4.83; 95% CI, 1.96-11.93; $P < .001$) increased the risk of infection, whereas use of the catheter for systemic antibiotic therapy (HR, 0.41; 95% CI, 0.18-0.93; $P = .03$) decreased the risk of infectious complications. Microorganisms recovered from catheter cultures are summarized in **TABLE 4**.

Thrombotic Complications. Of the 223 patients (77.2%) who underwent ultrasonographic examination for detection of a catheter-related thrombosis, 116 were in the femoral group and 107 were in the subclavian group. Among the 66 patients in whom ultrasonography was not performed, 41 (65%) died before catheter removal or ultrasonographic examination, 10 were discharged from the hospital before examination was performed, and the examination was refused or not done in 15 patients (including 7 unsuccessful catheter insertions). Catheter-related thromboses were detected in 25 patients (21.5%) who received a femoral catheter and in 2 (1.9%) who received a subclavian catheter ($P < .001$). Four cases of fibrin sleeves were found in the femoral group and none in the subclavian group. Major catheter-related thromboses occurred in 7 patients (6%) in the femoral group and none in the subclavian group ($P = .01$). Complete thrombosis was suspected on clinical examination in 5 patients in the femoral group. Significant factors associated with occurrence of a thrombotic

complication in bivariate analysis were insertion at the femoral site and center (1 center had a lower risk and 1 center had a higher risk). In a multivariate logistic regression model (Hosmer-Lemeshow χ^2 = noncalculable; likelihood ratio test $\chi^2_1 = 23.8$), the only risk factor for thrombotic complications was insertion at the femoral site (OR, 14.42; 95% CI, 3.33-62.57; $P < .001$).

Overall Reduction in Complications. The estimated absolute risk reduction associated with subclavian catheterization rather than femoral catheterization was 33% (95% CI, 23%-43%) for all complications and 6% (95% CI, 0.2%-12%) for major complications. Consequently, 3 patients (95% CI, 2-4) would need to be treated using subclavian rather than femoral catheterization to prevent 1 complication of catheterization, and 16 patients (95% CI, 8-411) to prevent 1 major complication.

COMMENT

In this prospective, randomized, concealed multicenter study in critically ill patients, we found that catheterization of the femoral vein was associated with a significantly higher risk of overall complications compared with catheterization of the subclavian vein. Femoral catheterization increased the risk of catheter-related infection and thrombosis, whereas the rate of mechanical complications did not differ between the 2 groups. To our knowledge, this is the first randomized study providing direct comparison of 3 types of complications associated with subclavian and femoral catheterization.

Central venous catheter–related complications in critically ill patients are usually classified as mechanical, infectious, and thrombotic. In our study, the 4 major mechanical complications (2.8%) observed with the subclavian approach were pneumothoraces necessitating chest

Table 3. Catheter-Related Infectious Complications

Code*	Classification	Femoral Group, No. (n = 134)	Subclavian Group, No. (n = 136)	P Value†
NA	Sterile	100	127	NA
1	Contamination (<1000 colony-forming units/mL and no clinical sepsis)	7	3	NA
2	Colonization (≥1000 colony-forming units/mL and no clinical sepsis)	19	3	
3	Clinical sepsis without bloodstream infection	4	1	.07 <.001
4	Clinical sepsis with bloodstream infection	2	1	
5	Unable to discriminate between codes 2 and 3	2	1	

*Codes 2, 3, 4, and 5 were collectively considered catheter-related infectious complications. Codes 3 and 4 were considered major catheter-related infectious complications. NA indicates not applicable.
†Calculated using the log-rank test, comparing codes 3 + 4 in femoral vs subclavian groups and comparing codes 2-5 in femoral vs subclavian groups.

Table 4. Microorganisms Recovered From Colonized Catheters or Involved in Catheter-Related Clinical Sepsis With or Without Bloodstream Infection*

Microorganisms	Femoral Group, No.	Subclavian Group, No.
Gram-positive		
Coagulase-negative staphylococci	13	2
Staphylococcus aureus	1	1
Enterococcus species	4	1
Corynebacterium species	0	1
Gram-negative		
Enterobacteriaceae	10	2
Pseudomonas aeruginosa	4	0
Stenotrophomonas maltophila	0	1
Acinetobacter baumanii	2	0

*There were 2 polymicrobial isolations in the subclavian group and 5 in the femoral group. Numbers total more than those listed in text because more than 1 microorganism was found in some catheters.

tube insertion with uncomplicated course. This rate is similar to those previously reported.[3,4] Although it is clear that subclavian catheterization is not an innocuous procedure, mechanical complications associated with the femoral approach may also have serious consequences for the patient. The 2 major complications of the femoral approach were severe hematomas that required blood transfusion or surgery. Ultrasonographically guided central venous access might reduce the rate of these mechanical complications, as has been shown for the subclavian approach.[21] Analysis of the factors associated with catheter-related mechanical complications identified 3 independent risk factors: (1) the time needed for catheter insertion, a variable similar to the number of needle passes previously reported as a risk factor[3]; (2) insertion during the night, specific to ICU practice, which could be explained by operator fatigue or inexperience; and (3) a center effect. Although we have no definite explanation, the lattermost factor could be related to better reporting of minor complications by these centers but also to limited experience of the operator in accessing 1 of the 2 routes independent of their senior or resident status.[4]

Our study was designed to avoid the 2 major biases that usually lead to an increased incidence of femoral site infections in nonrandomized studies: (1) femoral access is often used in emergency situations, during which adequate procedures cannot be always fully respected, and (2) the femoral site is usually chosen for patients with a contraindication to a cervicothoracic insertion. Because these patients are more seriously ill, they might be at a greater risk for infectious complications. Although these 2 biases were eliminated in our study by elimination of catheters inserted during emergency procedures and by randomization, our results confirmed an increased risk of infection with the femoral site compared with the subclavian site by showing a 5-fold higher incidence density of catheter-related infectious complications for the femoral site. Furthermore, the incidence den-

sity of a major catheter-related infectious complication was 4 times higher, but the difference failed to reach statistical significance. As recently demonstrated, femoral catheter-related infections may be reduced by subcutaneous tunneling.[14] In our multivariate analysis, the femoral site was strongly associated with a higher risk of catheter-related infection. In addition, we found that the use of the catheters for administration of systemic antibiotics was an independent protective factor, as previously demonstrated by Raad et al.[22]

The most striking difference between the 2 sites of insertion relates to catheter-related thrombosis. We found a low thrombosis rate (1.9%) at the subclavian site compared with other investigations that also used duplex Doppler ultrasonography as a diagnostic tool[8,23] and found a thrombosis incidence ranging from 10% to 15%. In those studies, ultrasonographic examination was performed before or after catheter removal, whereas in our study, the examination was always performed after catheter removal. Partial thrombosis directly attached to the catheter or disappearing within a few hours following catheter removal may not have been detected with our diagnostic approach.[24] Comparatively, our rate of femoral catheter-related thrombosis (21%) was very similar to the 25% rate found by Trottier et al,[7] who also performed ultrasonographic examination after catheter withdrawal. Nonvisualization of a short proximal segment of the subclavian vein has also been reported as the cause of poorer sensitivity of duplex Doppler ultrasonography compared with venography.[9] However, in a more recent report, the sensitivity and specificity were evaluated to be 96% and 93%, respectively, for compression ultrasonography and 81% and 77%, respectively, for duplex Doppler ultrasonography.[25] Since we used both techniques, it is unlikely that the difference in thrombosis rate could be attributed to undetected subclavian vein thrombosis. Seven of our patients had complete femoral catheter-related thrombosis, and pulmonary embolism was documented

in 2. The risk of pulmonary embolism associated with upper-limb venous thrombosis is estimated to be between 9% and 36%,[25-28] whereas this risk is approximately 50% for the proximal lower-limb veins.[29,30] Together with the infection risk, this increased risk of thrombosis[6,7] also supports the recommendation that the femoral approach should be used cautiously for central venous catheterization.

The study design has 2 possible limitations. First, subsets of patients or conditions may exist for which each of the 2 sites may prove to have a higher or lower risk-benefit ratio compared with the opposite site (ie, patients with severe, refractory hypoxemia may be at greater risk from the subclavian route, while patients with morbid obesity may be at higher risk of femoral cannulation). Although this point may be particularly relevant for mechanical complications, it was deemed unethical to randomize patients with a demonstrated higher risk at 1 of the 2 sites. Second, indications for catheter removal were not predetermined. However, catheters were removed and cultured according to usual rules for suspicion of catheter-related sepsis, uselessness, clinical signs of venous thrombosis, malfunction, discharge from the ICU, or death. Moreover, the proportion of catheters removed because of suspicion of catheter-related sepsis was not statistically different between the 2 groups; nor was the time elapsed between catheter removal and ultrasonographic study.

Reducing catheter-related complications in critically ill patients is an important goal. Among the various preventive measures, the choice of insertion site is a critical but incompletely resolved issue. Randomized studies have demonstrated excess risk of infectious complications associated with the internal jugular approach compared with the subclavian approach unless catheter tunneling was performed.[31,32] However, the rates of infectious complications following catheterization at the femoral or internal jugular site have not been compared in a randomized trial. A higher rate of thrombosis associated with internal

jugular catheterization has been suggested by a prospective nonrandomized study,[8] but no randomized study has been performed to compare thrombosis risk with the subclavian or femoral route. Our study shows that subclavian catheterization should be preferred to femoral catheterization whenever possible. Additional large randomized trials comparing mechanical, infectious, and thrombotic complications are required to determine the respective risks of the different catheterization sites commonly used in the ICU, such as the internal jugular vein.

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